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Some Astronomical Curiosities.

By J. E. GORE, M.R.I.A.

THERE are many curious facts and observations connected with astronomy which are not usually mentioned in popular books on the subject. The following are some of these.

From experiments made in November, 1906, at Moscow, Professor Ceraski found that the light of the Sun's limb is only 31 to 38 times brighter than the illumination of the Earth's atmosphere close to the limb. This is a very unexpected result; and considering the comparative faintness of the Sun's corona during a total eclipse of the Sun, it is not surprising that all attempts to photograph it without an eclipse have failed.*

The so-called blackness of sun-spots is merely relative. They are really very bright. The most brilliant light which can be produced artificially looks like a black spot when projected on the Sun's disc.

M. Leo Brenner thinks that he has seen the dark side of the planet Mercury in the same way that the dark side of Venus has been seen by many observers. In the case of Mercury the "dark side" appeared *darker* than the back ground of the sky. Perhaps this may be due to its being projected on the Zodiacal Light, or outer envelope of the Sun.†

When Venus is at its greatest brilliancy and appears as a morning star about Christmas time (which occurred in 1887 and again in 1889), it has been mistaken by the public for a return of the "Star of Bethlehem!" But whatever "the Star of the Magi" was it certainly was not Venus. It seems indeed absurd to suppose that "the wise men" of the East should have mistaken a familiar object like Venus for a strange apparition. There seems to be nothing whatever in the Bible to lead us to expect that the Star of Bethlehem will reappear. Mr. J. H. Stockwell has suggested‡ that the "Star of Bethlehem" may perhaps be explained by a conjunction of the planets Venus and Jupiter which occurred on May 8, B.C. 6, about two years before the death of Herod. From this it would follow that the Crucifixion took place on April 3, A.D. 33. But it seems very doubtful that the phenomenon recorded in the Bible refers to any conjunction of planets.

The crescent shape of Venus is said to have been seen with the naked eye by Theodore Parker in America when he was only 12 years old. Other observers have stated the same thing; but the possibility of such an observation has been much disputed in recent years.

The well-known French astronomer, Trouvelot—a most excellent observer—saw white spots on Venus similar to those on Mars. These were well seen and quite brilliant in July and August, 1876, and in February and November, 1877. The observations seem to show that these spots do not (unlike Mars) increase and decrease with the planet's seasons. These white spots had been previously noticed by former observers, including Bianchini, Derham, Gruithuisen, and La Hire; but these early observers do not seem to have considered them as snow caps, like those of Mars. Trouvelot was led by his own observations to conclude that the period of rotation of Venus is short, and the best result he obtained was $23^h\ 49^m\ 28^s$. This does not differ much from the results previously found by De Vien, Fritsch, and Schröter.* A white spot near the planet's south pole was seen on several occasions by H. C. Russell in May and June, 1876.† Photographs of Venus taken on March 18 and April 29, 1908, by M. Quénisset at the Observatory of Juvissy, France, show a white polar spot. The spot was also seen at the same Observatory by M. A. Benoit on May 20, 1903.

The controversy on the period of rotation of Venus, or the length of its day, is a very curious one, and has not yet been decided. Many good observers assert confidently that it is short (about 24 hours), while others affirm with equal confidence that it is long (about 225 days, the period of the planet's revolution round the Sun). Among the observers who favour the short period are D. Cassini (1667), J. Cassini (1730), Schröter (1788-93), Mädler (1836), De Vico (1840 ?), Trouvelot (1871-9), Flammarion, Leo Brenner, Stanley Williams, and J. M'Harg; and among those who support the long period are Bianchini (1727), Schiaparelli, Cerulli, Tacchini, Mascari, and Lowell. Some recent spectroscopic observations seem to favour the short period.

The "secondary light" of Venus, or the visibility of the dark side (when the planet is in the crescent phase) seems to have been first mentioned by Derham in his "Astro Theology," published in 1715. He speaks of the visibility of the dark part of the planet's disc "by the aid of a light of a somewhat dull and ruddy colour." The date of Derham's observation is not given; but it seems to have been previous to the year 1714. The light seems to have been also seen by a friend of Derham. We next find observations by Christfried Kirch, Assistant Astronomer to the Berlin Academy of Sciences, on June 7, 1721, and March 8, 1726. These observations are found in his original papers, and were printed in the *Astronomische Nachrichten*, No. 1586. On the first date the telescopic image of the planet was "rather tremulous," but in 1726 he noticed that the dark part seemed to belong to a smaller circle than the illuminated portion of the disc. The same effect was also noted by Webb. A similar appearance is seen in the case of the crescent Moon, and this has giver rise to the old saying: "The old Moon in the new Moon's arms."

We next come in order of date to an observation made by Andrias Mayer, Professor of Mathematics at Greifs-

* *Nature*, April 11, 1907. † *Nature*, Nov. 29 and Dec. 20, 1894.
‡ *Nature*, Dec. 22, 1892.

* *Nature*, Sept. 15 1892 † *The Observatory*, 1880, p. 574.

wald in Prussia. The observation was made on October 20, 1759, and the dark part of Venus was seen distinctly by Mayer. As the planet's altitude at the time was not more than 14° above the horizon, and its apparent distance from the Sun only 10°, the phenomenon—as Professor Safarik has pointed out—"must have had a most unusual intensity."

Sir William Herschel makes no mention of having ever seen the "secondary light" of Venus, although he noticed the extension of the horns beyond a semi-circle.

In the spring and summer of the year 1793 Von Hahn, of Remplin, in Mecklenburg, using excellent telescopes, made by Dolland and Herschel, saw the dark part of Venus on several occasions, and describes the light as "grey verging upon brown."

Schröter, of Lilienthal—the famous observer of the Moon—saw the horns of the crescent of Venus extended many degrees beyond the semicircle on several occasions in 1784 and 1795, and the border of the dark part faintly lit up by a dusky grey light. On Feb. 14, 1806, at 7 p.m. he saw the whole of the dark part visible with an ash-coloured light, and he was satisfied that there was no illusion. On Jan. 24 of the same year (1806) Harding at Göttingen, using a reflector of 9 inches aperture and power 84, saw the dark side "shining with a pale ash-coloured light," and very visible against the dark background of the sky. The appearance was seen with various magnifying powers, and he thought there could be no illusion. In fact, the phenomenon was as evident as in the case of the Moon. Harding again saw it on Feb. 28 of the same year, the illumination being of a reddish grey colour, "like that of the Moon in a total eclipse."

The "light" was also seen by Pastorff in 1822, and by Gruithuisen in 1825. Since 1824 observations were made by Berry, Browning, Guthrie, Langdon, Noble, Prince, Webb, and others. Webb saw it with powers of 90 and 212 on a 9·38-inch mirror and found it "equally visible when the bright crescent was hidden by a field bar."* Captain Noble's observation was rather unique. He found that the dark side was "always distinctly and positively *darker* than the background upon which it is projected." The "light" was also seen by Lyman in America in 1867, and by Safarik at Prague. In 1871 the whole disc of Venus was seen by Professor Winnecke.† On the other hand, Winnecke stated that he had only seen it twice in 24 years! The great observers Dawes and Mädler never saw it at all!‡

Various attempts have been made to explain the visibility, at times, of the "dark side" of Venus. The following may be mentioned‖: (1) Reflected earth-light analogous to the dark side of the crescent moon. This theory was advocated by Harding, Schröter, and others. But, although the earth is undoubtedly a bright object in the sky of Venus the explanation is evidently quite inadequate. (2) Phosphorescence of the planet's atmosphere. (3) Visibility by contrast, a hypothesis advanced by the great French astronomer Arago. (4) Illumination of the planet's surface by an aurora. This also seems rather inadequate, but would account for the light being sometimes visible and sometimes not. (5) Luminosity of the oceans—if there be any—on Venus. But this also seems inadequate. (6) A planetary surface glowing with intense heat. But this seems improbable; and (7) the *Kunstleiche Feur* (artificial fire) of Gruithuisen, a very fanciful hypothesis. Flammarion thinks that it may perhaps be explained by its projection on a somewhat lighter background, such as the Zodiacal Light, on an extended solar envelope.*

It will be seen that none of these hypotheses are entirely satisfactory, and the phenomenon, if real, remains a sort of astronomical enigma. The fact that the "light" is visible on some occasions and not on others would render some of the explanations improbable or even inadmissible. But the condition of the Earth's atmosphere at times might account for its invisibility on many occasions.

M. Hansky finds that the visibility of the "light" is greater during periods of maximum solar activity, that is at the maxima of sun-spots. This he explains by the theory of Arrhenius in which "electrified ions emitted by the Sun cause the phenomena of terrestrial magnetic storms and auroras. In the same way the dense atmosphere of Venus is rendered more phosphorescent and therefore more easily visible by the increased solar activity."† This seems a very plausible hypothesis.

There is a curious illusion with reference to the Moon's apparent diameter referred to by Proctor.‡ If, when the Moon is absent in the winter months, we ask a person whether the Moon's diameter is greater or less than the distance between the stars δ and ϵ, and ϵ and ζ Orionis (the three well-known stars in the belt of Orion), the answer will probably be that the Moon's apparent diameter is about equal to each of these distances. But in reality the apparent distance between δ and ϵ Orionis (or between ϵ and ζ, which is about the same) is more than double the Moon's apparent diameter. This seems at first sight a startling statement; but its truth is, of course, beyond all doubt, and is not open to argument. Proctor points out that if a person estimates the Moon as a foot in diameter, as its apparent diameter is about half a degree, this would imply that the observer estimates the circumference of the star sphere as about 720 feet ($360° \times 2$), and hence the radius (or the Moon's distance from the Earth) about 115 feet. But in reality all such estimates have no scientific (that is accurate) meaning. Some of the Ancients, such as Aristotle, Cicero, and Heraclitus seem to have estimated the Moon's apparent diameter at a foot.‖ This shows that even great minds may make serious mistakes.

Chacornac found that the illumination of Saturn's disc is the reverse of that of Jupiter, the edges of Saturn being *brighter* than the centre, while in the case of Jupiter—as that of the Sun—the edges are fainter than the centre. According to Mr. Denning, Saturn bears satisfactorily greater magnifying power than either Mars or Jupiter.

It was computed by M. Faye that the *volume* of the famous Donati's comet (1858) was about 500 times that of the Sun! On the other hand, he calculated that its mass (or quantity of matter it contained) was only a fraction of the earth's mass. This shows how almost inconceivably tenuous the material forming the comet must have been—much more rarefied indeed than the most perfect vacuum which can be produced in an air pump! This tenuity is shown by the fact that stars were seen through the tail "as if the tail did not exist." A mist of a few hundred yards in thickness is sufficient to hide the stars from our view, while a thickness of thousands of miles of cometary matter does not suffice even to dim their brilliancy.

On Nov. 29, 1905, Sir David Gill observed a fireball with an apparent diameter equal to that of the Moon, which remained visible for five minutes and then disappeared in a hazy sky. Observed from another place,

* *Celestial Objects*, Vol. I., p. 65 (Fifth Edition).
† *Ast. Nach.*, No. 1863. ‡ *Nature*, June 1, 1876.
‖ *Nature*, June 8, 1876.

* *Nature*, Oct. 17, 1895. † *Nature*, July 27, 1905.
‡ *Nature*, March 3, 1870. ‖ *Nature*, March 31, 1870, p. 557.

Mr. Fuller found that the meteor was visible two hours later! Sir David Gill stated that he does not know of any similar phenomenon.*

During the night of July 21-22, 1896, Mr. William Brooks, the well-known astronomer, and Director of the Smith Observatory at Geneva (New York), saw a round dark body pass slowly across the Moon's bright disc, the moon being nearly full at the time. The apparent diameter of the object was about one minute of arc, and the duration of the transit 3 or 4 seconds, the direction of motion being from East to West. On Aug. 22 of the same year, Mr. Guthman (an American observer) saw a meteor crossing the *Sun's* disc, the transit lasting about 8 seconds.†

A meteor which appeared in Italy on July 7, 1892, was shown by Prof. von Niessl to have an ascending path towards the latter end of its course! The length of its path was computed to be 683 miles. When first seen its height above the earth was about 42 miles, and when it disappeared its height had increased to about 98 miles, showing that its motion was directed upwards! ‡

In the case of the fall of meteoric stones, which occasionally occurs, it has sometimes been noticed that the sound caused by the explosion of the meteorite, on its passage through the air, is heard before the meteorite is seen to fall. This has been explained by the fact that owing to the resistance of the air to a body moving at first with a high velocity its speed is so reduced that it strikes the earth with a velocity less than that of sound. Hence the sound reaches the observer before the body strikes the ground.‖

In Central Arizona (U.S.A.) there is a hill called Coon Butte, or Coon Mountain. This so-called "mountain" rises to a height of only 130 to 160 ft. above the surrounding plain, and has on its top a crater of 530 to 560 ft. deep; the bottom of the crater—which is dry—being thus 400 ft. below the level of the surrounding country. This so-called "crater" is almost circular, and nearly three-quarters of a mile in diameter. It has been suggested that this "crater" was formed by the fall of an enormous iron meteorite, or small asteroid. The crater has been carefully examined by a geologist and a physicist. From the evidence and facts found, the geologist (Mr. Barringer) states that "they do not leave in my mind a scintilla of doubt that this mountain and its crater were produced by the impact of a large meteorite or small asteroid." The physicist (Mr. Tilghmann) says that he "is justified, under due reserve as to subsequently developed facts, in announcing that the formation at this locality is due to the impact of a meteor of enormous and unprecedented size." There are numerous masses of meteoric iron in the vicinity of the "crater." The so-called Canyon Diabolo meteorite was found in a canyon of that name, about 2½ miles from the Coon Mountain. The investigators estimate that the great meteoric fall took place "not more than 5000 years ago, perhaps much less." Cedar trees about 700 years old are now growing on the rim of the mountain. From the results of artillery experiments, Mr. Gilbert finds that "a spherical projectile striking solid limestone with a velocity of 1800 feet a second will penetrate to a depth of something less than two diameters," and from this Mr. L. Fletcher concludes "that a meteor of large size would not be prevented by the earth's atmosphere from having a penetrative effect sufficient for the production of such a crater."

* *Bulletin, Ast. So. de France*, May, 1906.

† *Nature*, Sept. 10, 1896. ‡ *Nature*, June 9, 1893.

‖ *Journal*, B.A.A., May 22, 1903.

The Canyon Diabolo meteorite above referred to was found to contain diamonds! some black, others transparent. So some have said that "the diamond is a gift from Heaven" conveyed to earth in meteoric showers. But diamond-bearing meteorites would seem to be rather a freak of nature. It does not follow that *all* diamonds had their origin in meteoric stones. The mineral periodot is frequently found in meteoric stones, but it is also a constituent of terrestrial rocks.

With reference to the rising and setting of the stars, due to the earth's rotation on its axis, the late Sir George Airy, Astronomer-Royal of England, once said to a schoolmaster, "I should like to know how far your pupils go into the first practical points, for which reading is scarcely necessary. Do they know that the stars rise and set? Very few people in England know it. I once had a correspondence with a literary man of the highest rank on a point of Greek astronomy, and found that he did not know it!"*

On the 4th of March, 1796, the famous French astronomer, Lalande, observed on the meridian a star of small 6th magnitude, the exact position of which he determined. On the 15th of the same month he again observed the star, and the places found on these two nights refer to the numbers 16292-3 of the reduced catalogue. In the observation of March 4, he attached the curious remark, "Étoile singulière." (The observation of March 15 is without note.) This remark of Lalande has puzzled observers, who failed to find any peculiarity about the star. Indeed, "the remark is a strange one for the observer of so many thousands of stars to attach, unless there was really something singular in the star's aspect at the time." On the evening of April 18, 1887, the star was examined by the present writer, and the following is the record in his observing book: "Lalande's étoile singulière (16292-3) about half a magnitude less than η Cancri. With the binocular I see two streams of small stars branching out from it north proceeding [north-west] like the tails of a comet." This may, perhaps, have something to do with Lalande's curious remark.

Burnham once saw a faint companion to Sirius of the 16th magnitude, and measured its position. But he afterwards found that it was "not a real object but a reflection from Sirius" (in the eyepiece). Such false images are called "ghosts."

With reference to the well known double (or rather quadruple) star ϵ Lyræ, near Vega, and supposed faint star near it, Burnham says: "From time to time various small stars in the vicinity have been mapped, and much time wasted in looking for and speculating about objects which only exist in the imagination of the observer." He thinks that many of these faint stars supposed to have been seen by various observers are merely "ghosts produced by reflection."

It is a curious fact that the performance of a really good refracting telescope actually exceeds what theory would indicate! at least, so far as double stars are concerned. For example, the famous double star observer, Dawes, found that the distance between the components of a double star which can just be divided is found by dividing 4″·56 by the aperture in inches. Now theory gives 5″·52 divided by the aperture. "The actual telescope—if a really good one—thus exceeds its theoretical requirements. The difference between theory and practice in this case seems to be due to the fact that in the 'spurious' disc shown by a good telescope, the illumination at the edges of the star disc is very feeble, so that its full size is not seen except in case of a very bright star."

* *The Observatory*, July, 1895, p. 290.

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The star known as W Ursæ Majoris (the variability of which was discovered by Muller and Kempf in 1902), and which lies between the Stars θ and υ of that constellation, has the marvellously short period of 4 hours (from maximum to maximum). Messrs. Jordan and Parkhurst (U.S.A.) find from photographic plates that the star varies from 7·24 to 8·17 magnitude. The light at maximum is therefore more than double the light at minimum. A sun which loses more than half its light and recovers it again in the short period of 4 hours is certainly a curious and wonderful object.

Dr. See, observing with the telescope of the Lowell Observatory, found that when the sky is clear, the Moon absent, and the seeing perfect, the sky appeared in patches to be of a brownish colour, and suggests that this colour owes its existence to immense cosmical clouds, which are shining by excessively feeble light! Dr. See found that these brown patches seem to cluster in certain regions of the Milky Way!

Some curious and interesting phenomena are recorded in the old Chinese annals which go back to a great antiquity. In B.C. 687 "a night" is mentioned "without clouds and without stars"! This may perhaps refer to a total eclipse of the Sun; but if so the eclipse is not mentioned in the Chinese list of eclipses. In the year 141 B.C. it is stated that the Sun and Moon appeared of a deep red colour during five days, a phenomenon which caused great terror among the people. In 74 B.C. it is related that a star as large as the Moon appeared, and was followed in its motion by several stars of ordinary size. This probably refers to an unusually large "bolide" or "fire-ball." In 38 B.C. a fall of meteoric stones is recorded "of the size of a walnut." In 88 A.D. another fall of stones is mentioned. In A.D. 321 sun-spots were visible to the naked eye.

There is a story of an eminent astronomer who had been on several eclipse expeditions, and yet was heard to remark that he had never seen an eclipse. "But your observations of several eclipses are on record," it was objected. "Certainly, I have on several occasions made observations, but I have always been too busy to look at the eclipse." He was probably in a dark tent taking photographs, or using a spectroscope during the totality.

The Stone-Curlew, or Thick-knee.

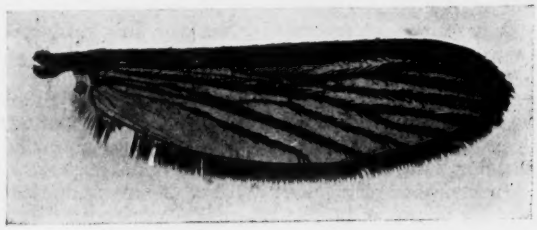
An Example of Protective Mimicry.

THE birds shown in our illustrations are the young of the Stone-Curlew, or Thick-knee, a plover-like bird, which lays its eggs on the bare ground, often among sand and scattered stones, which they closely resemble in colour. Although able to run well and quickly, these birds, when danger threatens, prostrate themselves flat on the sandy soil, with which their downy covering harmonises to a wonderful degree. They will suffer handling without relaxing the stiffness of their attitude, apparently having great faith in the protective value of their surroundings, or, as Mr. Abbot Thayrer might put it, "concealment effects." The eggs, two in number, are laid on the bare ground, and are protected similarly.

Science in the Soudan.

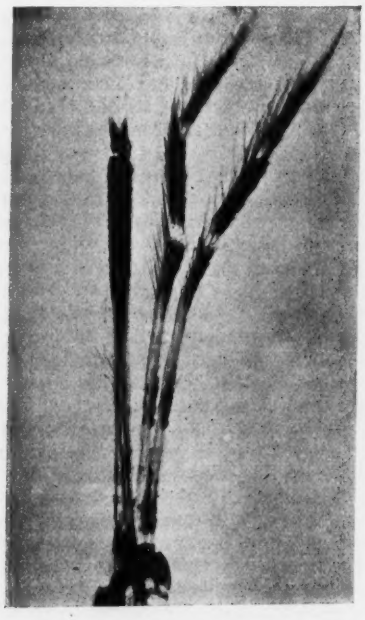
Third Report of the Wellcome Research Laboratories.

IT was a Dervish imagined by Mr. Rudyard Kipling who commented on the fa'e-stricken madness of the English, who laid the sons of the desert low with Lee-Metfords and shrapnel, and then raised for them a college in which they might learn the white man's lore. Of the method in the madness an example is afforded by the reports of the work which is done at the Wellcome



Wing of Culex Salus—New Type of Salt Water Mosquito.

Research Laboratories at the Gordon Memorial College, Khartum, and in the third of these, which in completeness and size surpasses its predecessors, there is an illustration in point. One of the most interesting contributions to this volume is written by Dr. Hassan Effendi Zeki, who is now the medical officer of the Gordon Memorial College, but who long before that college was



Proboscis and Palpi of Culex Salus.

built occupied the perilous post of medical adviser to the Khalifa. Some of the microscopic photographs of blood films in this finely illustrated volume are partly due to the efficiency of the chief laboratory attendant, who was a fighting Dervish at Kordofan. One of his assistants fought against us at Omdurman.

It would not be easy to do justice to the many sections

The Stone-Curlew, or Thick-knee.

An Example of Protective Mimicry.

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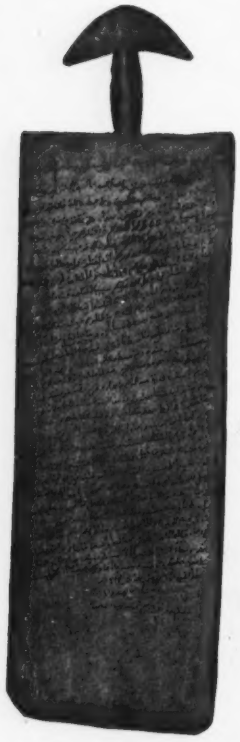
of this volume, except in articles specially allotted to consideration of the subjects of Tropical Diseases, Parasitology, Protozoology, Pathology, Entomology, Anthropology, Medicine, and Economic Chemistry, which it embraces; and we must be content therefore with noting a few points of specific interest. One of these points is the work done in determining the life history of Spirochætes in Sudanese fowls; an interesting problem in protozoology. It is not without interest for the fowls, because the Sudanese fowl is a constant and extreme sufferer; and it is possible that with the newly awakened interest in it as an object of clinical research, its fate may be to some extent bettered. At present its miserable existence is terminated only by lengthened and miserable death, for the Sudanese natives treat it with extreme cruelty in the market place, and it is perhaps the toughest and least savoury table bird known to mankind. Better treatment would make it a more palatable as well as a more profitable article of merchandise.

Burun—Sitting Posture.

One of the most agreeable chapters in the records of the work at Khartum has been the success attending efforts to make the place more sanitary for Europeans. Chief among the difficulties is the situation of the town, which is built on both sides of the river, and should have been re-built only on the north side. But, in spite of many natural and artificial difficulties, the town has been made healthy to live in; and its great plague, the numerous mosquitoes, has been reduced to an incredible extent. "That insect is, as a rule, represented only by one species, *Culex fatigans*. It is true that occasionally *Stegomyia fasciata* has reappeared, but it has never gained a footing in the town. The same is true of the anopheline mosquito, *Pyretophorus costalis*. This mosquito, on one of its rare appearances, was associated with a small outbreak of malaria. The mosquitoes which bred out in river pools above and beyond the confines of the town acquired their infection from old and recrudescent malaria cases in the British Barracks. . . . With the destruction of the few larvæ found, the small epidemic came to an end." Dr. Andrew Balfour, the Director of the Laboratories, who is responsible both for the volume as a whole and for the chapter on Khartum, mentions the use of the plant *Derris uliginosa* as a larvicide. It seems to be very effective, but it is suspected of being dangerous to fish as well as to mosquito larvæ.

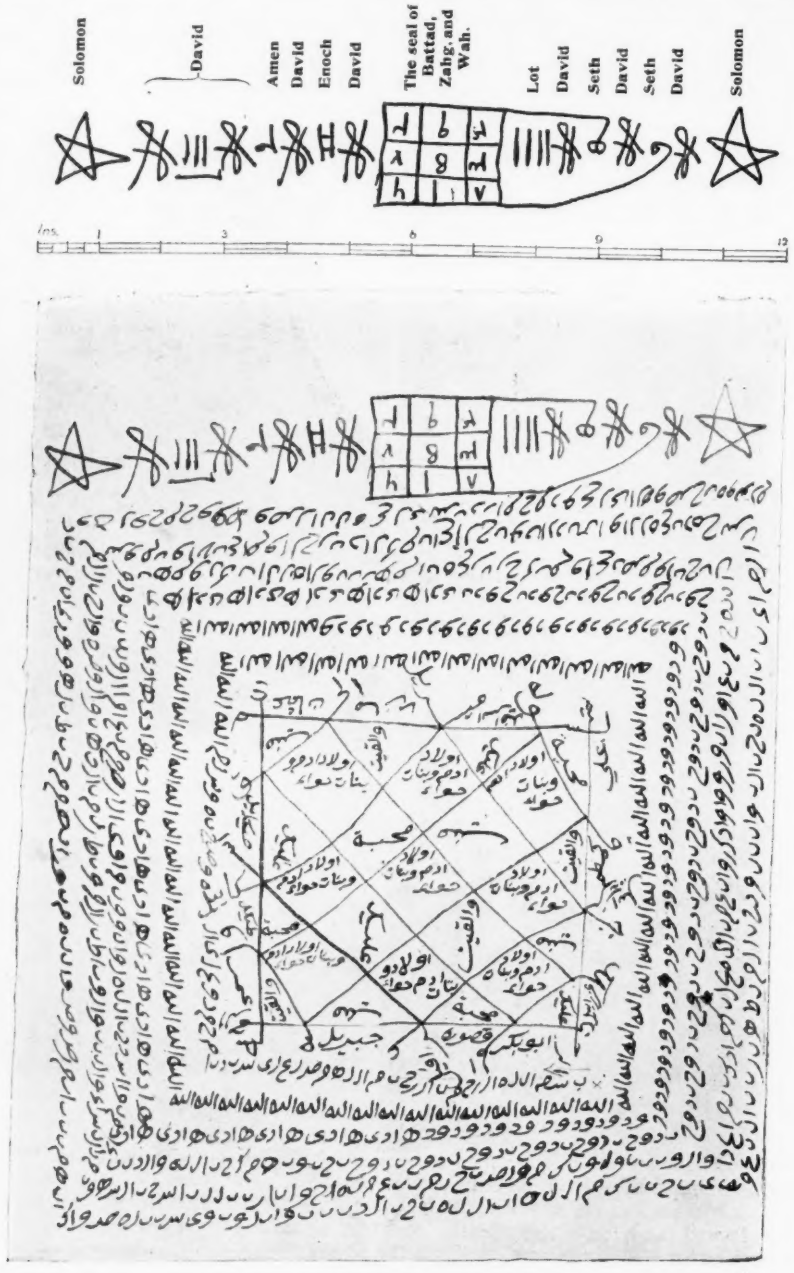
In the chapter on "Economic Entomology," which, as one might expect from the Land of Flies, is one of the longest and most important in the book, Mr. Harold H. King mentions the yearly outbreaks of fever among the

Nile natives in the Northern Soudan, and attributes their spread to the malarial *Pyretophorus costalis*. Mr. King's report is supplemented by a description written by Mr. F. V. Theobald of six new species of mosquitoes, of which we illustrate one. This is the *Culex salus*, a new salt water-breeding mosquito which was found at Port Sudan by Dr. Crispin. Fortunately this species appears to be very particular as to its breeding places, as so far its larvæ have only been seen in one salt-tub and one salt water pool. Some attention is given by Dr. R. G. Archibald and Captain Howard Ensor to the *Glossina palpalis* associated with sleeping sickness. *Glossina palpalis* and *Glossina morsitans* are the only tsetse flies found in the Bahr-el-Gazal province; but while *G. morsitans* is both much more numerous and a far more persistent and troublesome bloodsucker, there seems to be reason for supposing that the criminal fly which introduces parasitic disease is the *G. palpalis*. Captain Ensor mentions an interesting observation to the effect that the two species of *Glossina* appear to possess what he terms "definite spheres of influence," and never encroach on each other's hunting grounds. He adduces evidence in confirmation of this statement, and says that, in their enthusiasm for bloodsucking, flies of the *G. morsitans*



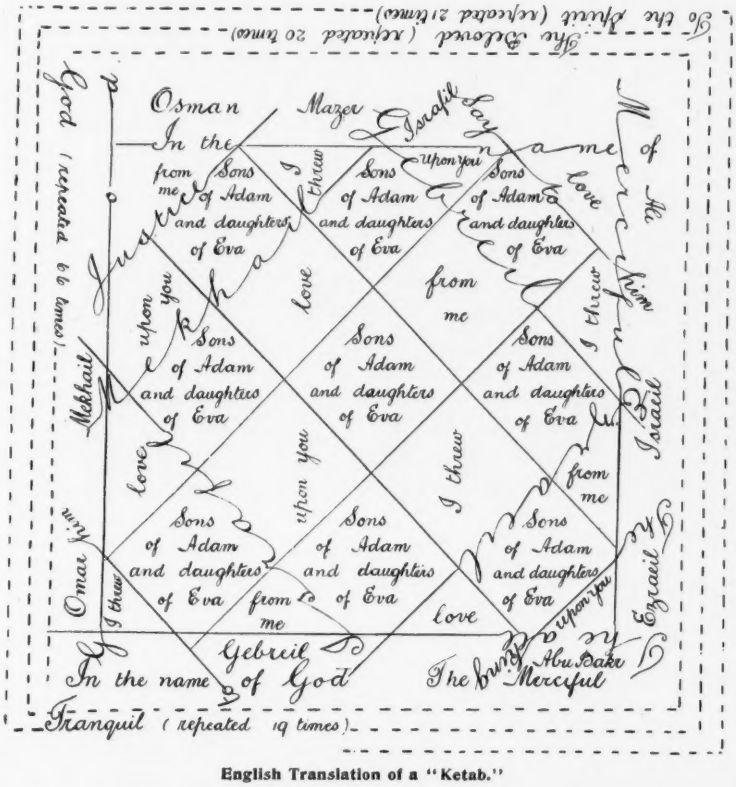
Lohn, or Writing Board, on which phrases from the Koran are inscribed. The ink when dry is washed off and the resulting fluid taken as medicine.

Holy Water from the Prophets' Well at Mecca, imported in metal flasks by pilgrims.



Love Charm, or "Ketab," showing the construction of a "Khatim," or Magic Square.

species will often follow one into a *G. palpalis* area, but that they then almost invariably disappear in a minute or two, their place being taken by hungry specimens of *G. palpalis*. The *G. palpalis* seldom moves more than ten or twenty yards from the water which it haunts, and Captain Ensor lays great stress on the clearing of trees, bushes, and grass surrounding all places whence drinking water is obtained. Dr. Archibald adds that this wholesale clearing will have to be maintained, and he points out, as Professor Minchin has done, that the *G. palpalis* is practically omnivorous where vertebrate blood is concerned. If, however, the fly will attack any vertebrate, man included, we do not quite understand how his suggestion that "all animals which offer the fly a means of sustenance should be destroyed" is to be put into practice. Dr. Archibald speaks regretfully of the failure of atoxyl as a curative agent.



English Translation of a "Ketab."

We have spoken of Dr. Hassan Effendi Zeki's position as doctor to the Khalifa, and as an authority on the medicine and surgery of the Dervishes. The surgery seems to have been of the most terrifying description. According to his paper, which is translated from the Arabic, surgical measures, till the Mahdi died, were carried out wholly by men termed *El Busara*, this being the plural of *Bassir*. The *Bassir* was also a druggist, and a "wise physician," and commonly a quack. Ground coffee to arrest hæmorrhage; native butter or boiling tallow with gunpowder as dressings; ribs of palm leaf as splints and calico as bandages—these were some of his accessories. Most of the natives objected to his operative attentions, preferring death to bungling. Bullet wounds were treated with oil, beeswax, and honey—plugged in to keep out the air. But it was in amputations that the methods were most heroic. The limb to be amputated was stretched out of an opening in the wall of the dwelling or out of a window by the assistant, the latter standing outside and to the right of the limb. A pillow was placed under the limb and then the *Bassir* severed the latter with one stroke of a sharp sword. The stump was at once plunged into boiling oil and hæmorrhage in this way speedily arrested. A bandage of calico was applied, and after three days a first dressing with butter was carried out. The wound was then dressed daily until it had healed or until death supervened—no uncommon occurrence. Of course, no anæsthetic was employed, and in some cases the person undergoing the operation was expected to render help to the *Bassir* by handing him instruments, etc. He was also expected to repeat the prayers of the Mahdi, and was taught to believe that all these ills of the flesh were intended to happen, and that they must be considered as cause for rejoicing. The Mahdi issued proclamations to this effect. Some of the patients were exceedingly stoical and endured the pain and wounds without a murmur. During convalescence, especially in the case of fractures, the *Busara* advised the patients to eat dates, said to be the most useful diet for promoting union of bone. In case of delayed union they were wont to assert that failure was due to an insufficient quantity of dates having been eaten.

Medical remedies were less appalling—though pouring hot tallow up the nose as a remedy for headache seems something more than adequate—but for most diseases charms and spells were and are provided. Most diseases, observed Dr. R. G. Anderson, of Kordofan, are produced, according to the native idea, by: (1) The evil eye; (2) evil spirits and influences. The lamented Khalifa was a great believer in the evil eye; and there is apparently no sign-manual (as in the South of Europe) to repel its influence. One can, however, ward it off by pointing at its possessor a long white piece of bone covered with soot at one end. Children, who are most susceptible, wear charms round their necks. Next to the evil eye is the influence of evil spirits: genii, afrete, shatan, baahi, fairies, ghosts, men possessed (Zarr, Shaukh, &c.), all apparently under the very nominal control of Suliman, son of David, their chief. Among them are Tiltamish, Yakoush, Habteet, Attatsh, Anshil, Bouni, Agbareet, Touni, Saroum—local spirits in Kordofan like El Ahmar and Abu Seleba, and some specially depraved ones like a certain Um El Sibian, who accounts for greater harm and who apparently provokes more preventive charms than a dozen others. She is the goddess of sterility and destruction, a lean and loathsome old woman.

Charms against these spirits are holy and mystic writings, contained in neat rectangular or cylindrical cases of red leather, ornamented and suspended on a leather carrying-string singly or in numbers. The charms are strange mixtures of religion and paganism, with sentences from the Koran interwoven and interspersed with ancient charms, and in arrangements of immemorially old magic squares. Roots of trees, certain rare stones, and stones from the graves of the Holy are also among the charms; and there are many rare and curious forms of rite and

incantation. Before leaving the subject of cures, we may quote one which appears to be less doubtful than the rest and which is a form of massage. A strongly-scented paste made from ground dura, marissa grounds, fat, oil, given to the skin and muscles. Such procedure largely takes the place of our hot-bath, whilst in wasting diseases, fever, rheumatism, strains, sprains, and the like no better treatment could be employed.

Burtas Building Bamboo Huts.

water, and such aromatics as *fitna* (a complex Eastern perfume), *magmoa*, *surratia*, *zet sandalia*, and *baida*, to which various medicaments may be added where therapeutic results are aimed at. This paste is rubbed piecemeal over the entire body from head to foot, and gradually worked off with a strong kneading action. With it all dead epithelium is removed, and a refreshing "tone"

A melancholy interest attaches to the section on Anthropology, part of the work in which was undertaken by the late Dr. Mac Tier Pirrie, who died before his work had well begun. Its results appear in the materials summarized by Dr. David Waterston, of Edinburgh; and contribute to the feeling of loss sustained by Dr. Pirrie's death. The observations and photographs of the

Native Soudanese Splints applied to forearm.

Nuers, Dinkas, and Shilluks are minute, painstaking, and illuminating; and some of the most interesting pages are those in respect of the Buruns, a tribe hitherto largely unknown. Dr. Pirrie wrote:—

"Before one comes into close proximity with a Burun he says in a distinct voice 'Mooka,' which means friend; thereupon the word 'Mooka' is to be returned, and their peculiar handshake follows. This is effected by both parties mutually snapping the first and second fingers together against the thumb. Were it not the fact that the Burun smears himself with vegetable oil and war-paint, this form of greeting would be wholly unobjectionable; as it is, however, he invariably leaves an impression which the average white man is slow to appreciate.

"Another extraordinary form of greeting I occasionally found amongst the Buruns was the 'afoo' (in Arabic). This is possibly of Arab origin. It consists in making the third-finger knuckles crack over the head of the saluted. This is done in perfect silence as regards speech, and each walks away without saying a word. It is also practised upon the sick, and is supposed to afford them material relief.

"The Dinkas, Shilluks, and Nuers have an interesting snake-magic. I am inclined to think that the Dinkas practise it most. It is rather snake-magic than snake-worship, though to a casual observer, imbued with the mystery which surrounds the subject, it would appear as though the Dinkas actually worship their snakes. The Dinka is remarkably reticent on the matter, a fact which is to be explained by reference to the uses to which snake-magic is put. If a Dinka has an enemy he may cause his snake, or one of the particular species with whose magic he is conversant, to inflict injury upon the enemy, or upon his family or cattle. If anyone has been bitten by a snake, or has had a narrow escape from a snake, or has merely seen a snake, or heard one rustling in the grass, he is sure to make enquiries as to the master of these snakes, for to his mind every snake has a master. Some snake-master, perhaps in another village, hears of this incident, and smiles grimly, whereupon men draw their conclusions.

"A snake-magician is considered wonderful, for he is so astute that he seldom or never gives himself away. If he is clever he can ward off the snakes of other magicians. They require, so they say, to keep a special cow for the snake, that it may never lack milk. If they have no cow they will set apart a goat for the same purpose, and if they have neither cow nor goat they are unable to practise snake-magic at all. Cows and goats set apart for this purpose are never given in exchange for wives and cattle."

The April Lyrids.

The time of new moon almost coinciding with the epoch of the Lyrid meteors this year, a favourable opportunity should occur for re-observing the shower. Seldom very active and occasionally recognised with difficulty, it does not rank equally with such systems as the Perseids, Leonids, and Andromedids, but for several reasons it deserves to be classed with some of our more prominent and important streams. It has a cometary derivation, it is periodically rich, as in 1803, and its meteors often fairly numerous But the display is remarkable for its brevity, possibly in many years when it appears nearly absent it may have occurred in the day-time, in cloudy weather, or amid moonlight sufficiently strong to obliterate it.

Burrowing Animals.

By W. P. Pycraft, F.L.S., F.Z.S., M.B.O.U., &c.

The modifiability or plasticity of animals in relation to the needs of their environment is perhaps nowhere more strikingly shown than in the case of those which burrow in the earth for their daily bread; for the degree of structural adaptation to their peculiar needs stands in very close relation to the exigencies of the struggle for existence in this respect.

Thus there are quite a number of beasts and birds, for example, among which burrowing is only, so to speak, incidental—that is to say, they are not compelled to burrow for a livelihood, but only to secure shelter when at rest or nurseries for their young; and such creatures often contrive to find all they require in natural holes and crannies, or in the deserted tenements of other excavators. These give little or no evidence of their burrowing capacity in their bodily structure. The rabbit and the fox, the water vole, and the prairie-dog among the mammals, and the sand-martin, bee-eater, and kingfisher among the birds, for example, bear, in their physical structure, no evidence of their ability to construct burrows. Indeed, the feeble-footed birds just named might well be supposed to be utterly incapable of the engineering feats which they actually accomplish, for the little sand-martin, with which all my readers must be familiar, is capable of driving a tunnel several yards in length into a sand-bank, his only tools being a tiny beak and ridiculously short legs and fragile toes! If nothing were known of its habits, the mere examination of its body would make the suggestion that it was a burrower seem ridiculous. More especially so from our knowledge of the life history of its cousin the house-martin. The bee-eaters, though long of beak, have very small feet, and the front toes are closely bound together so that lateral movement between them is impossible. Yet they, too, construct tunnels of as much as 10 feet in length!

The rabbit, for all one could gather from an examination of its body, would be as little likely to be a burrowing animal as the hare; and the same is true of a number of other burrowers. But the case is entirely different with animals which seek their daily bread beneath the surface of the ground. Before examining these in detail, however, let us briefly scrutinize a number of animals which are adepts at digging, and bear evidence of more or less considerable structural modifications to this end, though at the same time they seek their food above ground.

Among the mammalia the most conspicuous examples are perhaps the armadillos. The bulk of the food, at any rate, of these creatures is obtained above ground, but the fore-feet are armed with powerful claws which attain their maximum size in the Great Armadillo, *Priodon giganteus*, wherein the third toe and claw have attained a relatively enormous size while the remainder are degenerate; in other species there is less disparity between the digits. These toes are used for scraping away the walls of ants' nests and digging up other insect food, worms, and so on. The fact that they are skilled burrowers—so skilled, that if a horseman endeavours to capture one of these creatures he must tumble off his horse on to the top of his prey if he is to secure it before it is swallowed up in the earth—does not imply that this modification of the limbs has come about in adaptation to this end, for the giant ant-eater (*Myrmecophaga jubata*) and the little ant-eater (*Cycloturus didactylus*) have even more powerful feet, yet they do not burrow. In the last named species, indeed, the third toe has attained an enormous size, while the second is reduced to a mere

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spindle; the first and fourth are represented only by vestiges, and the fifth is wanting altogether. These creatures use their feet for tearing open the nests of ants, as do the armadillos, but they have not learned, because they have not needed, to burrow. Between digging and burrowing there is but little difference however, and we may imagine that the latter habit arose in many of these powerful-footed creatures in chasing escaping prey; so that an animal which was originally a surface feeder came by degrees to elect to feed mainly, if not entirely, underground.

The mole is one of the best instances probably of this change of habit, and in dry weather it still obtains much of its food above ground, ferreting about among the roots of grass in search of worms and insects. But by far the greater part of its life is passed entirely underground in the pursuit of the worms and such insect larvæ as lie buried beneath the surface. And, as a consequence, the

Skeleton of the foot of the Great Armadillo (*Priodon giganteus*).

Note the degenerate condition of the pollex and index digit, and the great size of the middle finger.

Skeleton of the foot of the Common Mole (*Talpa Europæus*).

In this foot the fingers are of about equal size, and the width thereof is increased by its curved falciform bone F.

Skeleton of the foot of the Little Ant-eater (*Cycloturus didactylus*).

Note the degenerate condition of the pollex, index, and fourth fingers, and the huge size of the middle digit.

animal has undergone some very striking structural changes. The eyes have almost vanished, there is no ear-conch, and the fore limbs have become so excessively shortened that only the hand projects beyond the body, and this hand is of enormous size, and turned so that the palms look directly backwards. Even the nature of the fur has changed, inasmuch as it is short, like velvet pile, and being thicker in the middle than at the base and tip can be brushed either way, a very useful modification, enabling the animal to walk backwards in a tunnel too narrow to turn round in, without damaging the fur.

It is, however, in the skeleton that the most profound changes have taken place; and these changes have all been brought about to afford increased leverage for muscles, since it is obvious that immense muscular power is essential for a creature that is to force its way beneath the surface of the ground. One of the North American web-footed moles—a near relative of the common mole (*Talpa Europæus*)—has been known in a single night to form a gallery several yards in length. As Dr. Hart Merriam remarks, "in order to perform equivalent work a man would have to excavate in a single night a tunnel thirty-seven miles long, and of sufficient size to easily admit of the passage of his body."

The web-footed mole, by the way, presents us with a riddle. It is so called because the hind-feet are webbed, as if for swimming, yet the creature, so far as is known, shuns the water. The common mole, on the other hand, has no such webs, is an excellent swimmer, and takes readily to water.

In its subterranean mode of life the typical mole has found many imitators. South Africa, for example, possesses several species of "golden moles," creatures which are nearly related to the tenrecs of Madagascar, small insectivora allied to the hedgehogs. Now the golden mole, though superficially very mole-like, being practically eyeless and earless and provided with powerful digging fore-limbs, yet shows its independent origin by its internal structure. For though apparently short-limbed, as to the fore legs, the skeleton of the limb reveals a relatively long arm and fore-arm. More than this, the humerus and ulna have a unique structure, for the former has the internal condyle produced into a huge spur, while the olecranon process of the ulna is brought out to form a great blade-shaped plate, so arranged as to cross the spur of the humerus. This arrangement affords attachment for very powerful digging muscles, and these are further supplemented in a very remarkable manner, a club-shaped rod of bone running from the wrist joint, upwards and backwards, parallel with the fore-arm, to terminate in a free end near the elbow joint. This rod apparently represents an ossified tendon. This development of what we may call extra-skeletal bones to serve special ends is met with in many different animals. In the common mole, for example, the width of the great hand is still further increased by a large semilunar rod of bone, apparently representing a sesamoid. This and the peculiar modifications of the fore limb in the golden mole are both devices to attain the same end—greater attachment for the digging muscles. The fur of the golden mole is even more remarkable than that of the typical mole, inasmuch as it displays a most wonderful iridescence varying from golden-bronze to green and violet of different shades of intensity.

No more striking illustrations could be found of the way in which totally unrelated animals come to assume the same superficial likeness, in adaptation to a similar mode of life, than are to be met with among the mole-like mammalia. The species so far described are members of the order Insectivora, and, therefore, more or less related. But besides these we meet with several species of mole-like animals which belong to a totally distinct order, to wit, the Rodents; and yet another, to which reference will be made presently, belongs to the Marsupialia!

Of the mole-like rodents let us take for example the odd-looking mole-rat (*Spalax typhlus*), which, like the typical mole, has reversible fur. In the matter of sight it is even more degenerate than the mole with which most of us are so familiar, for its eyes are completely covered by skin; small wart-like ear conches, however, remain, vestiges of an earlier, once useful ear. This creature, a native of South-East Europe, extending eastwards into Persia and Lower Egypt, tunnels like the mole, but in search of bulbs and roots—asphodels and hyacinths being a favourite diet, which, probably, most of us would consider an improvement on a diet of worms! The borings of this animal are of great length, extending as much as 40 yards, and at a depth of some 18 inches from the surface. The common mole, it may be remembered, is said to dig deep pockets, storing at the bottom thereof earthworms, which are bitten through so as to prevent their escape; similarly the mole-rat digs larders of as much as four-feet deep, and therein a bountiful supply of its favourite bulbs is placed.

Northern India, China, Burma, and the Malayan region harbour no less remarkable mole-like creatures known as Bamboo-rats, the largest of which, a native of Sumatra, attains relatively brobdingnagian proportions, measuring some 19 inches in length exclusive of the tail!

Africa, south of the Sahara, harbours several types of creatures known as mole-rats. One of these, which is found at the Cape, measures a foot in length, and is armed with enormous teeth and extremely powerful claws. But perhaps the most extraordinary of the African mole-rats are the naked sand-rats of the genus *Heterocephalus*. There are two species, which for repulsiveness in appearance could not readily be matched, and this because they are so scantily clothed that only after a most careful inspection of the wrinkled skin can one assure oneself that they are not absolutely naked. This feature in itself makes for ugliness, but the finishing touches in this direction are made in the relatively small head and huge teeth! The limbs of these impish little rodents are less mole-like than in most of the species herein described, and the tail is moderately long. This retention of the more normal type of limb is noteworthy,

Heterocephalus glaber.

The body of this animal is quite hairless, and the eyes reduced to mere vestiges, and though a skilled burrower, the limbs have undergone no very striking changes.

as the degenerate eyes and ears and the hairlessness of the skin show that they must have long been subjected to a subterranean life. As burrowers they are very expert, throwing up groups of "miniature craters" as they go, and ejecting loose earth from the bottom of the crater in a succession of little jerks and with great force.

Finally, we come to the Marsupial mole, *Notoryctes*. The discovery of this creature in Central South Australia, by Professor Stirling, and the excitement this discovery created in scientific circles, may be within the memory of most of my readers. It bears a very close likeness to the typical mole, and even in the matter of colour, which is of a bright golden hue, it is matched by certain not uncommon varieties of the common mole. Like this creature it is practically blind, having but vestiges of eyes, and is also earless; but it differs from its prototype

The Marsupial Mole (*Notoryctes typhlops*).

Note the horny shield on the nose, the great size of the second claw in the fore-foot, and contrast this foot with that of the Mole.

externally in having a horny pad on the snout, and two huge claws on the fore-limb, in place of the broad shovel-hand and narrow claws; while furthermore it has a pouch on the abdomen—the hall-mark of the marsupial. Internally it presents many peculiar characters. True to the traditions of its house, it bears within its body the rod-like Marsupial bones attached to the pelvis, while certain of the vertebræ in the neck and lumbar region are firmly welded together as in the armadillos. This, of course, adds strength of drive in tunnelling. The track of the animal is said to resemble that of a railway in a mountainous country.

(To be continued.)

Is There a Trans-Neptunian Planet?

By F. W. HENKEL, B.A., F.R.A.S.

IN 1877 Professor Todd, from a graphic investigation of the still outstanding differences between the computed and the observed places of Uranus, after allowing for the action of Neptune, considered that an unknown planet existed lying beyond the latter. He accordingly made search for it with the great Washington telescope, but was unable to find any such body.

Professor George Forbes has recently revived some earlier calculations indicating the possible existence of a trans-Neptunian planet, and he considers his former speculations have been greatly strengthened by additional facts unknown to him at the earlier period. He thinks that three comets which appeared in 1843, 1880, and 1882 are in reality parts of the comet of 1556 (sometimes known as the comet of Charles V., from its appearing at the time of that monarch's abdication), which has been broken up by the action of an unknown planet lying beyond Neptune. It is well known that the planets Jupiter, Saturn, Uranus, and Neptune are associated in an especial way with particular comets. For instance, the short period comets known by the name of Faye, De Vico, Brorsen, and Encke, which revolve in elliptic orbits having periods of revolution round the Sun of from three to eight years, all of them approach at certain parts of their orbits very close to that of the planet Jupiter. Similarly, Halley's comet, whose return is hourly expected, Olbers' comet of 1812, and Pons' comet of 1812, rediscovered by Mr. Brooks in 1883, approach very near to the orbit of Neptune, their greatest distance from the Sun (aphelion) lying a little beyond that planet. Tempel's comet and two others are similarly associated with Uranus. These various comets are frequently called the "planets' families" of comets, and they are supposed to have become so in the following way. A comet coming from outer space into our system towards the Sun will have its rectilinear motion converted into a parabolic one, will approach the Sun with increasing speed till it arrives at its nearest point (perihelion), and then once more recede from it. If, however, it comes near a planet in its motion its speed will either be accelerated or retarded. If accelerated the parabola becomes a hyperbola, and the comet moves off even more quickly from the Sun after perihelion. If, however, it is retarded the parabolic orbit is changed into an ellipse, which is a closed curve, and the comet will now become a permanent member of the system, moving in a path which will pass through the region where the disturbance originally took place. The successive diminutions of velocity may greatly transform the comet's original orbit. The converse instance of an increase of speed seems to have happened in the case of Lexell's comet of 1770, which, it is thought, has had its elliptic orbit made hyperbolic by the action of Jupiter.

Another theory as to the origin of comet families, suggested by the late Mr. Proctor, supposes these bodies to have been thrown off by some kind of eruptions from the Sun and planets—*e.g.*, that the comets of Jupiter's family once formed part of his mass, but were ejected with sufficient speed to set them free in space, though still under the Sun's influence.

On either theory we see that there must be some connection between the comets and the planets to whose families they respectively belong.

As we have seen above, Professor Forbes considers the three comets 1843I., 1880I., and 1882II. were originally

parts of one and the same body. Their aphelion (greatest) distance from the sun is about the same, 88 times the Earth's distance, and the common position of all three is in longitude 101° and latitude 35° S. Seven comets have been found having their greatest distance at about 100 times the Earth's distance from the Sun, and four of these have their orbits lying nearly in a plane passing through the Sun. He, therefore, suggests that this is in all probability the true plane of the orbit of an unknown planet revolving at about that distance from the Sun, and consequently having a period of revolution of about 1000 years, in accordance with Kepler's third law. [The squares of the periodic times of revolution are as the cubes of the mean distances from the Sun. Expressed in terms of the Earth's distance and period as units, $(100)^3 = 1{,}000{,}000 = (1000)^2$.] The dates at which the comets were in aphelion were found to agree fairly well with the dates on which a planet of the periodic time of 1000 years would be found in or near those four positions, so that the position of the unknown planet may be considered approximately known. Estimates formed by roughly calculating the probable disturbances produced by this planet upon Neptune give such small quantities for the perturbations that no certain evidence of its existence is likely to be obtained by this method *at present*, unless its mass be enormously greater than that of Neptune, though sooner or later its presence may be thus revealed. Professor Forbes has estimated that the unknown planet has a mean distance from the Sun 105 times that of the Earth (more than three times Neptune's distance), that the inclination of the plane of its orbit to the ecliptic is about 52°, and that its elliptic orbit has an eccentricity of about ·16. The fact of the inclination of its path to the ecliptic causing it to be for large part of its revolution outside the region of the Zodiac, in which the search for new planets has been mainly carried on, may perhaps be the reason that it has hitherto escaped detection. Professor Forbes concludes that its present longitude in its orbit is about 202° (or 216° with regard to the ecliptic), and its south latitude (distance from the ecliptic) is 34°. It is consequently at present only to be looked for in the Southern hemisphere or from observatories nearer to the Equator than we are.

Professor W. H. Pickering has just given the place of a supposed trans-Neptunian planet. Its present position is in R.A. $7^h\ 47^m$, North Declination 21°; or in the south-eastern part of the constellation Gemini (the Twins). This cannot be the same object as that referred to by Professor Forbes, but nothing seems to prevent there being two or more bodies moving in planetary orbits outside the orbit of Neptune. It is quite certain that there are many comets revolving in elliptic orbits and thus returning from time to time to perihelion, which recede to far greater distances from the Sun. For instance, the famous comet of 1680, which approached so very close to the Sun at perihelion that it must have passed through the outer regions of the solar atmhephere, its distance being only about 550,000 miles from the Sun's centre at that time, recedes in its aphelion to a distance 850 times the Earth's distance, or 28 times that of Neptune from the Sun. The amount of light and heat received by an equal area of the comet at these respective times must accordingly be 19,000 million times more in perihelion than in aphelion, and its velocity also subject to enormous variations. The apparent diameter of the Sun would only be 2″ when seen from the comet at aphelion, whilst in perihelion, according to Newton, the comet would be subject to a heat "2000 times that of red-hot iron," the Sun subtending an angular diameter of 85°. Owing to the rapidity of its motion, however, the comet would only be subjected to this intense heat for a very short time.

At the other end of our system we have the question of an intra-Mercurial planet. Leverrier, whom we have already mentioned as one of the discoverers of Neptune, found in 1859 that the motion of Mercury is such that the perihelion (or point of least distance from the Sun) changes its position in a manner which cannot be altogether accounted for by the action of the other known planets. It might be explained by the attraction of a planet or a number of small planetoids revolving inside Mercury's orbit and lying nearly in the same plane.

Dr. Lescarbault, a French country physician, announced that he had seen a planet crossing the Sun on March 29, 1859. He was visited by Leverrier, who, after severe cross-questioning, apparently satisfied himself that Lescarbault's observation was a genuine one, and calculated an orbit therefrom, the name of Vulcan being given to the supposed planet. However, it has never been certainly seen again, though, if real, it ought several times to have been visible in transit across the Sun. Observations at the times of solar eclipses should certainly reveal the presence of such a body; but so far no one else has yet found the planet, though both Professor Watson and Mr. Swift, during the eclipse of 1878, thought they saw two bright objects which could not very well be identified with any known stars. Later investigations made by Dr. Peters have shown that Professor Watson's stars may very possibly have been the stars θ and ζ Cancri; but, so far, Mr. Swift's observations remain unexplained. However, up to the present, no planet lying nearer to the Sun than Mercury has been certainly found. Professor Young considers it "extremely probable that there are a number—perhaps a very great number—of intra-Mercurial asteroids," perhaps each of them not having a diameter exceeding 50 miles or so. So small objects, lying very near to the Sun, would be nearly certain to escape detection either in transit or during an eclipse.

Metropolitan Water Board. Second Report on Research Work, by Dr. A. C. Houston, Director of Water Examinations.—This report is on "the negative results of the examination of samples of *raw* Thames, Lea, and New River water for the presence of the typhoid bacillus. The chief epidemic diseases liable to be water-borne are held to be cholera, typhoid fever, and diarrhœa. In this report attention is directed solely to the question of water-borne typhoid infection. The author points out that there is an important distinction between "non-specific potentially dangerous" and "specific definitely dangerous" excremental pollution. So far as typhoid fever is concerned, the former means the absence, and the latter the presence of the typhoid bacillus in the contaminated material. It has been maintained that primary conceptions as to the undesirable contamination of a water are best based on enumeration of the intestinal microbes present in it, but that failure during a protracted period of time to discover the typhoid bacillus in a multiplicity of samples of the water may perhaps legitimately be allowed to fortify a favourable judgment as to non-specific biological quality of the water. Of course, everything depends on the nature of the negative evidence afforded in the above sense, and all that at present can be assumed is that the most recent tests for B. typhosus, applied to a considerable volume of raw river water, at weekly intervals, during a period of twelve months, and involving the study of 7,329 microbes, failed to reveal the presence of a single typhoid bacillus. Dr. Houston considers that it would, however, be altogether presumptuous to infer from these observations that the typhoid bacillus is never present in the raw river waters, or to conclude that any relaxation in the processes of purifying the raw waters, by storage or filtration, before delivery to consumer, is justifiable.

Radium and Vegetable Growth.

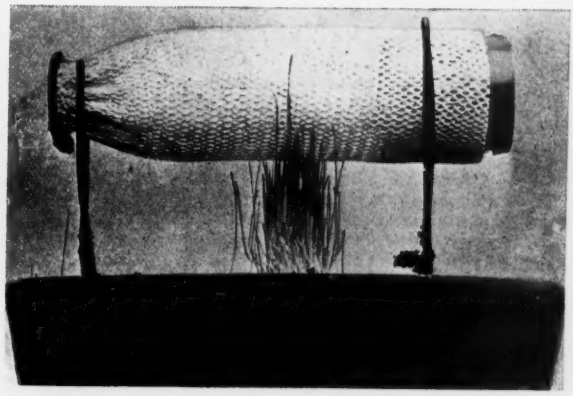
FOR some time past Professor Stuart Gager, of the University of Missouri, has been engaged in investigating the effects of the rays of radium on plants; and he has recently prepared a summary of some of the more definite conclusions. Our interest in the effect of radium rays on living organisms is enhanced by the discovery that radium is widely distributed in Nature. It is probable that all plants and animals are adjusted to a normal degree of radioactivity in their environment—in other words, are in a state of what Professor Gager calls "radiotonus." As Sir J. J. Thomson was the first to point out, radioactivity is probably a property of all spring waters; Elster and Geitel found radioactivity in the mud of hot springs and in the atmosphere. Air near the soil is more strongly radioactive than the air above the surface. All the evidence leads to the conclusion that radioactivity is due to the presence of the emanation of radium or other radioactive substances in the earth's crust; and it therefore must evidently be recognized as a factor, more or less constant, in plant life.

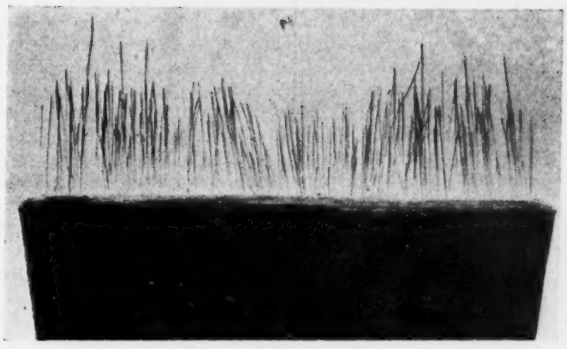
The effect of duration of exposure on the germination and growth of lupins (*Lupinus albus*) is shown in this illustration. The activity of the radium employed was the same in each case, 1,800,000. The seeds exposed were dry and the length of the exposure from left to right of the figure was 72 hours, 50 hours, 26 hours, 0 hours (control). This shows that the effect in inhibiting growth varies with the exposure.

Professor Gager's experiments were conducted with various strengths of radium. The purest radium bromide hitherto obtained is spoken of as having a radioactivity of 1,800,000. A sealed tube containing radium of this strength, and other tubes of R 1,500,000, R 10,000, and a rod of celluloid coated with R 25,000 were employed, as well as a sealed tube of radio-tellurium, which gives off only α rays (or helium atoms). In none of the experiments did the radium itself come into contact with the plant tissues. The results noted were due to the action of the rays alone. When the sealed glass tubes were used, the effects were therefore produced by the β and γ rays acting together (the glass stopping the α rays); when the radium coatings were employed all the rays, α, β, and γ, were in action, as well as the gaseous emanation.

Although exposure to radium rays may be followed in some cases by inhibition or retardation of function or growth, there are some cases where there is on the contrary an acceleration of growth. The conditions depend to some extent on the nature of exposure, and also on the nature of the tissues. Thus by creating a radioactive atmosphere in a bell jar over plants it was possible on the one hand to *retard* the growth of timothy grass over-exposed; but to *accelerate* the growth of lupin seeds which had already germinated. Similarly, excitation of function is further illustrated by the following experiment: In a flower pot of soil unsoaked seeds of oat were sown in three concentric circles, distant, respectively, 7 mm., 22 mm., and 45 mm. from the centre of the pot. Into the soil at the centre was inserted the sealed glass tube of radium bromide of 1,500,000 activity. The end containing the radium was about 15 mm. below the soil surface. A second pot was arranged in a like manner except for the

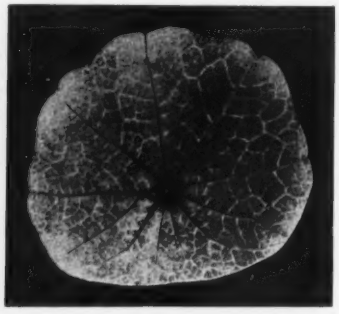
The relative effect of preparations of different activities is illustrated by this typical experiment. Three sets, *a*, *b*, and *c*, of six dry seeds of the white lupin were exposed to rays from sealed glass tubes of radium bromide by laying the tubes in contact with the hilum edges of the seeds. Care was taken to have the radium salt distributed evenly along the bottom of the horizontally placed tube. The activities of the preparations were: *a*, 1,800,000; *b*, 1,500,000; *c*, 10,000. A fourth set, *d*, served as a control. All exposures were for 91.5 hours. The seeds were then sown in soil in pots, and the comparative amounts of growth in the four cultures are shown. The activity decreased from left to right. It is clearly demonstrated that the stronger the activity the greater the amount of retardation, under the conditions of the experiment.





The fact that incandescent gas mantles contain a large percentage of thorium, a radioactive substance, suggested this experiment. On the surface of soil in a pot was sown a row of timothy grass seed, and over this row, and at right angles to it, was suspended a fresh, unburned mantle at a distance of three or four millimetres above the seeds. Germination and subsequent growth were both retarded by the rays from the mantle, and the second figure shows the appearance of the culture seven days after the experiment was started.

substitution of an empty glass tube for the radium tube. At the end of 106 hours the seedlings from the exposed seeds were much taller than those in the control pot, the amount of stimulation being greatest in the outer circle of plants and least in the inner circle. At the end of the 106-hour period the radium tube was placed in the control pot and the empty glass tube in the radium pot Following this change the seedlings in the control pot grew faster than those in the original radium pot. Thus it was possible to accelerate the growth of the seedlings in either pot at will by transferring the radium tube from one culture to the other.



A nasturtium (*Tropœolum*) plant was placed in sunlight after having been in darkness for 18 hours. Under one of the leaves, and lightly in contact with it, was placed a Lieber's coated rod of undetermined (probably 25,000) activity. After twenty-four hours the leaf was dechlorophyllized and stained with iodine to test the presence of starch. Starch was almost entirely wanting in the part of the leaf that was directly over the radium-coated rod, but was present in other portions of the leaf. The result was recorded by exposing the leaf to sunlight in contact with the velox paper in a printing-frame. The region lacking starch, being more translucent, gave the darkest image on the velox paper.

All the experiments described by Professor Gager were confirmed by repetitions, and clearly indicate that radium rays act as a stimulus to the various physiological processes of plants. If the strength of the radium, the duration of exposure, and other conditions are suitable, the response is an excitation of function, but if the method of treatment is otherwise—the radium too strong, the exposure too prolonged—the result is a retardation or complete inhibition of function, or the death of the plant. There are not only differences in sensitiveness between individuals, but also between different species and different tissues. As in the case of animals, embryonic and younger tissues are more sensitive than those that are older and more mature. We are indebted to the *Popular Science Monthly* (New York) for our illustrations and for the facts in Professor Gager's article.

Bullet Prints.

By DR. ALFRED GRADENWITZ.

DR. BALTHAZARD, of Paris, recently had to decide whether two lead bullets, one found on the carpet a day after, and the second three weeks after, a crime, had struck the victim. Owing to their low penetrating power, these bullets had in fact injured the arm without penetrating the clothes, after which they had recoiled. Balthazard now noted that these bullets bore a distinct impression of the tissue of the garments. After fixing the tissue on a wooden board and shooting at it with lead bullets he safely ascertained that the projectiles found on the floor really had struck the victim. This success then induced him to undertake further investigations, in the course of which he observed that projectiles after traversing garments (even if they afterwards penetrate the body to considerable depth) always show a distinct imprint of the tissue. Only when the bullet had undergone a deformation on striking a bone could this trace of the tissue be partially effaced. The process based on these researches now consists of fixing the tissue with drawing nails on a carefully planed board and shooting at it with bullets of the same calibre as the bullet found. Lead revolver bullets nearly always have the calibre of 8 millimetres, so that the process can be limited in practice to the use of a given revolver and one type of second quality cartridges. Such projectiles, being of very small penetrating power, recoil from the tissue without penetrating the wood.

The accompanying photographs of tissue imprints on lead projectiles are shown in a three-fold magnification, and relate to tissues of different fineness. The imprint is seen to differ widely, according to the nature of the tissue. When measuring this tissue by means of a compass, the identity or difference of any two given tissues can be safely ascertained. An even simpler process consists of counting on the imprint the number of threads corresponding to each centimetre of the warp and woof respectively. The difference between the rather substantial warp and very light woof is sometimes so conspicuous as to allow the tissue to be distinguished immediately, as for example in some coarse velvets. Certain tissues, such as those of shirt-fronts and collars, are made up of a superposition of several tissues of different woof, the finest placed uppermost. In such cases the projectile likewise bears a superposition of different imprints corresponding to each of the tissues. This ingenious discovery has enabled Dr. Balthazard to find out the garment worn by the victim of a murderous assault, and in the case of several wounds to state through which aperture a bullet found in the body had penetrated. He intends to publish the results of those researches in the form of an album containing imprints of all the different kinds of tissues.

Bullets which show the imprint of the textures of materials through which they have passed.

Light Cloth. **Fancy Cloth. The imprint of both sides of the cloth can be seen.** **Fine Linen.** **Heavy Cloth.**

Relationships Between the Spectra of Allied Elements.

By W. Marshall Watts, D.Sc.

(*Continued from page* 89.)

We find similar relationships existing between the spectra of calcium, strontium, and barium, as shown in Fig. 3. The spectra are now more complex, as is seen from the fact that of 106 lines in the arc-spectrum of calcium, only 36 can be accounted for by the formulæ of Kayser and Runge, in that of strontium 34 out of about 100, and in that of barium, with 162 lines, no series has been detected. In calcium and stontium no principal series is known, but Kayser and Runge have found two subordinate series, ending at about

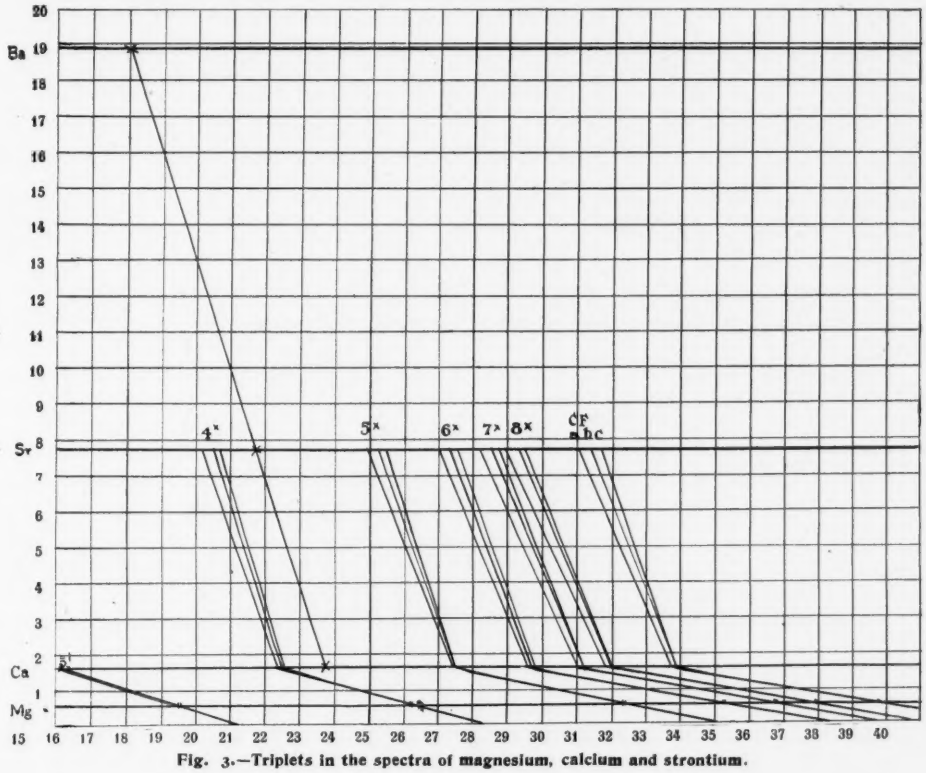


Fig. 3.—Triplets in the spectra of magnesium, calcium and strontium.

the same convergence-frequency for the two series in each element. In the diagram the triplets marked 4*, 5*, 6*, 7*, and 8* in Sr and Ca belong to the first subordinate series—the convergence-frequencies are marked $\frac{\text{C.F.}}{\text{a b c}}$. If we attempt to calculate the atomic weight of calcium from that of strontium by means of these triplets (in the same way as we calculated Rb from Cs), we have the following data:

Separation between the first and third lines of triplets:

	Strontium.	Calcium.
4*	581.0	154.5
5*	576.2	153.6
6*	570.4	156.0
7*	572.0	155.1
8*	576.5	159.4
Means	575.2	155.7

The atomic weight of strontium being 87.6 and its square, 7673.76, the proportion 575.2; 155.7 = 7673.76 : (at. wt. Ca)^2 gives 45.5 for Ca, whose true weight is 40.1.

This difference shows that the separation of these lines is not proportional to the square of the atomic weight, and this method of calculation therefore fails *for the present.*

Using the other relationship, viz., that between three elements, the difficulty is to discover which of the barium lines are homologous with strontium and calcium lines. There are, however, three lines which are certainly connected—the "metal-flame" lines, Ba 5536, Sr 4607, and Ca 4226 (seen in the photograph of flame-spectra, in "Knowledge" for June, 1908). These three lines are shown on the diagram connected by a straight line. Calculating the atomic weight of strontium from those of barium and calcium we obtain 87.4 instead of 87.6.

Other lines, which are possibly connected in the same way, are:—

	Barium.	Strontium.	Calcium.
(*a*)	24207.92	28863.53	31451.98
(*b*)	25693.93	29578.01	31655.79
(*c*)	20407.62	24522.54	26758.86
(*d*)	24002.46	28776.90	31432.70

Calculating with these data we obtain:—

(*a*)	=	88.2
(*b*)	=	87.3
(*c*)	=	87.7
(*d*)	=	88.2
Mean		87.9

None of these lines are series-lines; their homology is rendered probable by their similar behaviour in the magnetic field.

If, in Fig. 2 we plot corresponding lines of sodium under those of cæsium, rubidium, and potassium; and if, in Fig. 3 we plot those of magnesium under strontium and calcium, we observe that the connecting lines of Cs, Rb, and K cannot be produced to pass through those of Na; nor can the connecting lines of Sr and Ca be produced through those of Mg; and we are struck by the similarity of the two diagrams; the lines joining K and Na, and those joining Ca to Mg bending sharply to the right in each case. This is, no doubt, connected in some way with the chemical characters of the metals; Cs, Rb, and K being more closely related than K and Na; and Sr and Ca being more closely related than Ca and Mg.

In Fig. 4 we have shown the series-relationship between the allied elements cadmium and zinc. Here again no principal series is known, but there are two subordinate series of triplets, ending at nearly the same convergence-frequency, marked $\overset{C.}{*}\ \overset{F.}{\dagger}$ in the diagram. The diagram shows the triplets of the first subordinate series, 4*, 5*, 6*, 7*, and 8*; and three of the second subordinate series marked 3†, 4†, and 5†. A similar series of triplets, but of more complicated structure, is known in the spectrum of mercury, which from chemical considerations we should expect to show an analogy with the spectra of cadmium and zinc. The square of the atomic weight of mercury being 40,000, the mercury line is beyond the range of the diagram, but the straight connecting lines of the triplets of zinc and cadmium do not pass through the corresponding triplets of mercury, which lie considerably to the right. On inspecting the diagram we notice that the lines intersect on the line of zero atomic weight, which shows that the separations are proportional to the squares of the atomic weights. Taking the separations between the first and third lines of the triplets, we have the following data :—

	Cadmium.	Zinc.	Ratio.
3†	1713.0	578.7	2.960
4*	1701.3	571.0	2.980
4†	1711.2	578.5	2.952
5*	1699.3	575.8	2.951
5†	1713.0	578.6	2.061
6*	1704.0	576.4	2.956
6†	1713.2	579.2	2.958
7*	1704.7	576.4	2.943
7†	1664.9	586.4	2.839
8*	1639.4	546.3	3.001
8†	1700.5	578.1	2.042

The mean value of the ratio is 2.948, and the ratio of the squares of the atomic weights is 2.960. Calculating the atomic weight of zinc from that of cadmium (112.4), from these data we obtain—

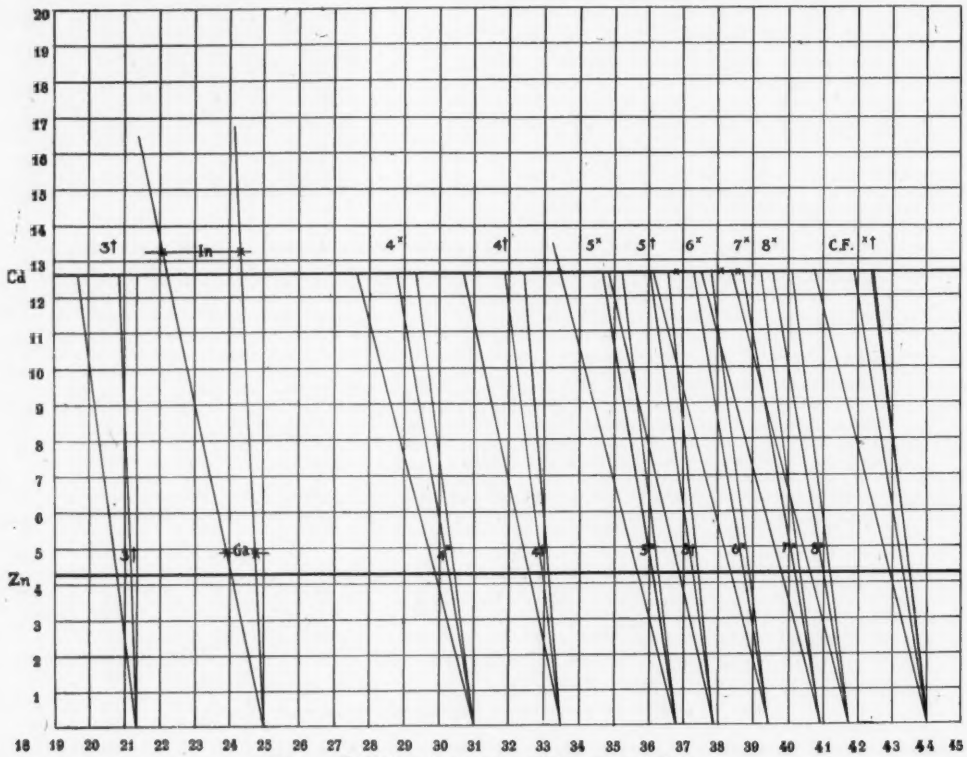


Fig. 4.—Triplets in the spectra of zinc and cadmium.

3†	65.33	6†	65.35
4*	65.12	7*	65.52
4†	65.35	7†	66.71
5*	65.43	8*	64.88
5†	65.32	8†	65.54
6*	65.37		

The mean of these numbers is 65.45; the accepted value of the atomic weight of zinc is 65.4. Another case of a similar relationship is found between the allied elements indium and gallium. In the indium spectrum there are fourteen pairs with the difference 2213, and in the gallium spectrum two pairs with difference 826 have been observed. The atomic weight of indium being 114.8, if we calculate that of gallium by the proportion

$$2213 : 826 = (114.8)^2 : (\text{at. wt. Ga})^2$$

we obtain 70.1 instead of 69.9.

We have seen that this method of calculating the atomic weight of one element from that of another by means of the separation between lines of pairs (or triplets) failed in the case of strontium and calcium; and the diagram shows that the connecting lines do not meet on the line of zero atomic weight, but below it. This shows that it is not universally true that the separations are proportional to squares of atomic weights; but it is probable that they are always proportional to *some power* of the atomic weight, which is about $\frac{5}{3}$ in the case of strontium and calcium; about $\frac{5}{2}$ in the group containing copper and silver; and so on. This is known as the law of Runge and Precht; it states that the difference in oscillation-frequency of homologous doublets is proportional to some power of the atomic weight, which is the same in the case of allied elements. Another way of expressing this is to say that the logarithm of the difference is a linear function of the logarithm of the atomic weight.

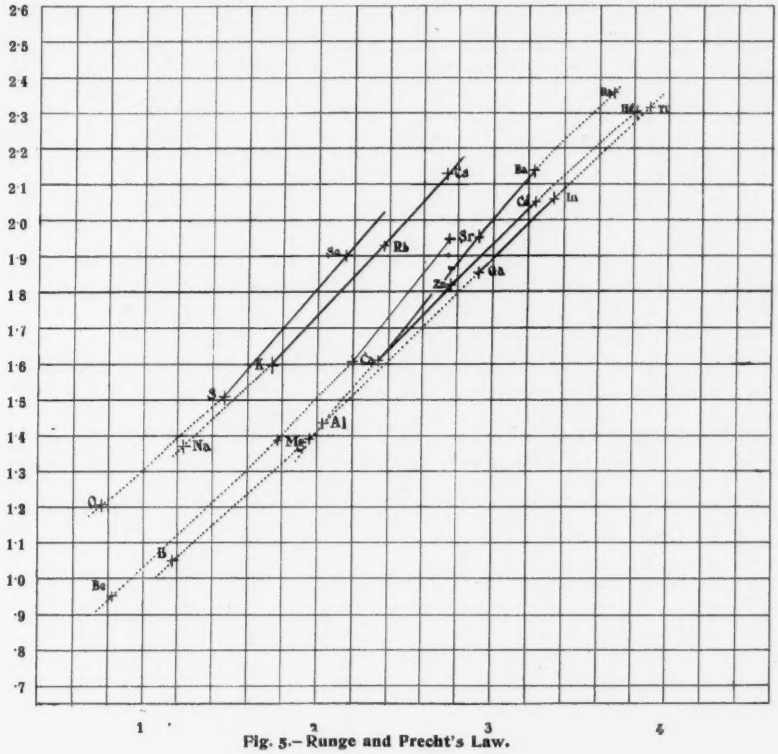


Fig. 5.—Runge and Precht's Law.

This will become clear by a study of the diagram Fig. 5, where logarithms of atomic weights are plotted as ordinates, and logarithms of separations as abscissæ. Taking the separations of the pairs in the subordinate series for Cs, Rb, and K, and plotting down the positions marked, we find that a straight line can be drawn through them. If produced downwards, the straight line fails to pass through Na *exactly*, as is shown by the dotted portion of the line, which is slightly curved upwards. The nearly parallel straight line drawn through Sr and Ca from the differences between the first and third lines of the triplets (as shown in Fig. 3) in like manner if produced downwards fails to pass *exactly* through Mg, but requires a bend upwards, as in the case of the Sr-Ca line; if continued far enough this curve passes through beryllium (Be), which the Periodic Law places in the same vertical column as Mg, Ca, Sr, and Ba. It will be observed that in this diagram the power of the atomic weight is indicated by the slope of the straight line.

The line drawn through Zn and Cd corresponds to the power 2; this line, if produced upwards, fails to pass through Hg unless, as shown by the dotted portion, we give it a certain small curvature downwards, and, in the same way the line drawn through Ga and In, if produced upwards passes through Tl only by giving it a slight curvature downwards similar to the Zn, Cd, Hg line; and if produced downwards with a slight curvature in the opposite direction, like the Sr. Ca, Mg, Be line, it passes through aluminium (Al) and Boron (B), which, in the table of the Periodic Law, occupy the same vertical column as Tl, In, and Ga.

It will be noticed that the diagram shows a *second* line marked Mg, Ca, Sr, and continued upwards through Ba. This is plotted for another set of lines not included in the triplet series. They are shown in the following table, including radium, and have been shown to be resolved in the same way in the magnetic field.

They are claimed by Kayser as belonging to *a* principal series, and two subordinate series.

		Ra	Ba	Sr	Ca	Mg	Resolution in the Magnetic Field.
Principal Series	{	4682	1934	4216	3969	2803	Like D_1
	{	3815	4554	4078	3934	2796	Like D_2
First Subordinate Series	{	4436	4166	3475	3181	—	
	{	4341	4131	3465	3179	2798	Triplet
	{	365›	3892	3381	3159	2791	Triplet
Second Subordinate Series	{	5814	4900	4306	3737	2937	Like D_2
	{	4533	4525	4162	3706	2929	Like D_1

The distances apart of corresponding lines are 4858.5 for Ra; 1691 for Ba; 801 for Sr; 223 for Ca; and 91.7 for Mg. Plotting these data we obtain the points marked in the diagram: a straight line can be drawn through Ca, Sr, and Ba, but this line if produced downwards fails to pass through Mg, requiring a slight upward curvature. By carrying the straight line through Ca, Sr, and Ba, upwards, Runge and Precht have determined the atomic weight of radium to be 257.8, but analogy with the lines through Zn and Cd to Hg, and through Ga and In to Tl seem to show that the line ought to curve downwards, in which case it might quite well pass through the point on the diagram marked Ra, which is plotted for the accepted value for Ra, viz.: 225.

The relationships shown in this diagram may be reduced to formulæ.

The formula given by Runge and Precht for the Mg, Ca, Sr, Ba line is:—

$$\text{log. at. wt.} = 0.2005 + 0.5997 \log. x,$$

when x denotes the separation of the lines of the doublets; this formula gives

Magnesium	...	23.84	instead of	24.32
Calcium	...	40.6	,,	40.1
Strontium	...	87.5	,,	87.6
Barium	...	136.9	,,	137.4

For the Zn-Cd line the formula is

$$\text{log. at. wt.} = 0.5405 + 0.4928 \log. x.$$

This gives Beryllium	...	8.8	instead of	9.1
Zinc	...	65.4	,,	65.4
Cadmium	...	112.4	,,	112.4
Mercury	...	222.5	,,	200.0

For the B, Al, Ga, In, Tl line, where the differences are 15.4, 112, 826.4, 2213.2, and 7794.2 respectively, the formula is

$$\text{log. at. wt.} = 0.4718 + 0.4773 \log. x.$$

This gives Boron	...	10.8	instead of	11
Aluminium	...	27.6	,,	27.1
Gallium	...	71.2	,,	69.9
Indium	...	113.5	,,	114.8
Thallium	...	206.0	,,	204.0

If we calculate a formula for the group containing copper and silver from the differences 248 and 920.8, we obtain

$$\text{log. at. wt.} = 0.8340 + 0.4378 \log. x,$$

and taking the differences of sodium and gold as 17.2 and 3817 respectively, we have

Sodium	...	21.52	instead of	23.0
Copper	...	63.6	,,	63.6
Silver	...	107.9	,,	107.9
Gold	...	196.7	,,	197.2

For the metals of the alkalies the formula is

$$\text{log. at. wt.} = 0.6221 + 0.5523 \log. x.$$

This gives Sodium	...	25.2	instead of	23.0
Potassium	...	39.15	,,	39.15
Rubidium	...	85.4	,,	85.4
Cæsium	...	136.0	,,	132.8

P.S.—It is stated in the above article that no series-lines have been detected in the spectrum of barium; but since that statement has been in type, the writer has become acquainted with some recent observations* of new lines of barium which show the existence of series-lines in barium corresponding to the triplets of magnesium, calcium, and strontium, shown in Fig. 3. The distance between the first and third lines of the barium triplets proves to be 1248.9, the logarithm of which is 3.09687. If this number is plotted on the diagram, Fig. 5, the line through Be, Mg, Ca, and Sr, if produced upwards, will be found to pass the new point exactly. The following formula represents the straight line through Ca and Sr:

$$\text{log. at. wt.} = .29137 + .59831 \log. x.$$

This gives Magnesium	...	22.82	instead of	24.3
Calcium	...	40.1	,,	40.1
Strontium	...	87.6	,,	87.6
Barium	...	139.4	,,	137.4

* Saunders. *Astrophl. Jl.*, xxviii., 223.

Photograph of the Moon.

THE portion of our satellite represented is the Mare Crisium and parts of the Mare Tranquillitalis, Mare Fœcunditatis and the Palus Somnii. This is not, perhaps, what has been one of the most active regions of the lunar surface, but it includes a considerable number of interesting features.

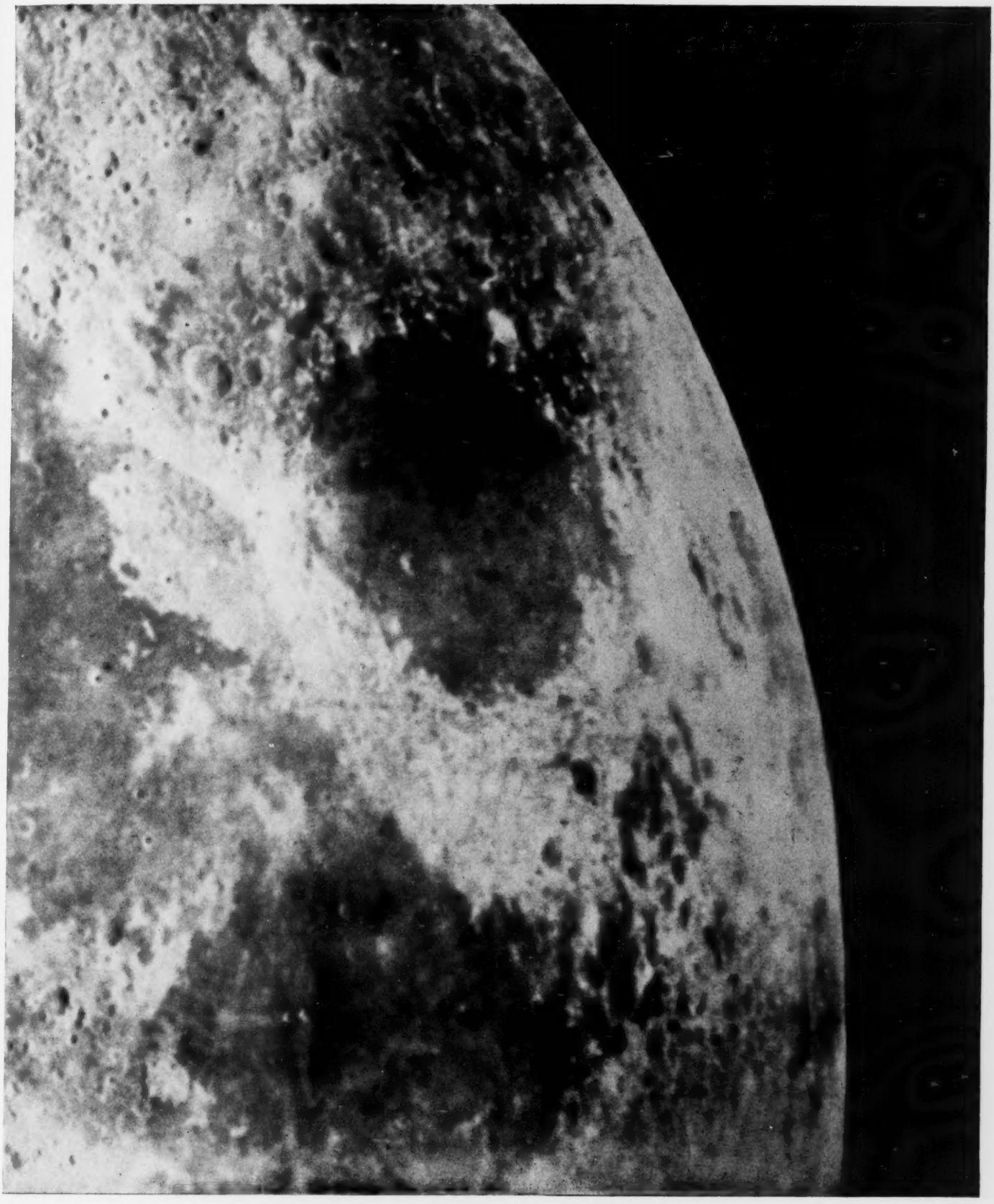
The Mare Crisium is a large and well bounded dark plain which may be easily distinguished with the unaided eye. It is an oval formation, the major axis lying from S.W., the extent being 350 miles, while from N. to S. the diameter is 280 miles. Its position, however, near the limb, causes it to appear elliptical N. to S. by the effects of foreshortening. The general level of this "sea" is lower than that of the neighbouring Maria, and the mountains bounding it are very lofty and precipitous in several instances. One on its S.E. side reaches about 15,500 feet; another on the W. border called the *Promontorium Agarum* ascends to 11,000 feet. There are some further rugged and lofty hills on the E. edge, where there is also an extensive valley with many other details of interest. Among these some of the old observers recorded singular changes and thought them physical, but there is every reason to suppose that they were due to differences in the illumination combined, perhaps, with varying definition due to the vagaries of our atmosphere.

The Mare Crisium contains a few craters of fair size and prominence of which Picard is the largest. On the side nearest the limb Schroeter figured a crater which he named Alhazen, but this seems to have escaped more modern observers, and the probability is that he really confounded it with a crater further S.

Cleomedes is an extensive walled plain nearly 80 miles in diameter lying just N. of the Mare Crisium. Within it may be observed a brilliant though small crater termed Cleomedes A, which seems to have a fluctuating visibility, though these can scarcely be ascribed to material changes in the object.

Messier and Messier A on the Mare Fœcunditatis consist of a pair of prominent and deep craters with a pair of singular nebulous streaks diverging from them far to the eastwards. Schroeter seems to have noticed the comet-like aspect of these crater-rays, and they were appropriately designated "Messier" in honour of one of the chief comet discoverers of the 18th century. Changes have been noticed both in the craters and in their luminous trails, and further critical observations are necessary.

Other objects included in the photograph are Burckhardt (35 miles in diameter), Geminus (54 miles and with a towering ring surrounding it), Bernonilli (deep interior and mountainous wall), Gauss (a large plain on border 110 miles long and with a fine peak in centre), Endymion (a walled plain of about 80 miles diameter, of very dark tone at full moon, and with high mountains surrounding it), and Macrobius (42 miles in diameter and 13,000 feet deep).



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The Moon.

XUM

A Mercury Surface Telescope.

AN extremely interesting and successful attempt to utilise the surface of rotating mercury was made last year by Mr. R. W. Wood, of Johns Hopkins University, and is described by him in the *Astrophysical Journal*. The free surface of a liquid rotating with a uniform velocity assumes the form of a paraboloid, and a telescope on this principle was constructed some forty years ago by Mr. R. C. Carrington. But the difficulties of obtaining a perfectly smooth surface to a rotating liquid, when the jars and shaking of the mechanism rotating it are taken into account, have usually been regarded as insuperable. To Mr. Wood the idea of using a rotating magnetic field to communicate motion to a circular basin of mercury seemed a promising one, and he set about experimenting to find out whether the jarring and shaking could be eliminated. First of all a small instrument was constructed which could be driven by a revolving ring of small magnets. These pulled a concentric ring of

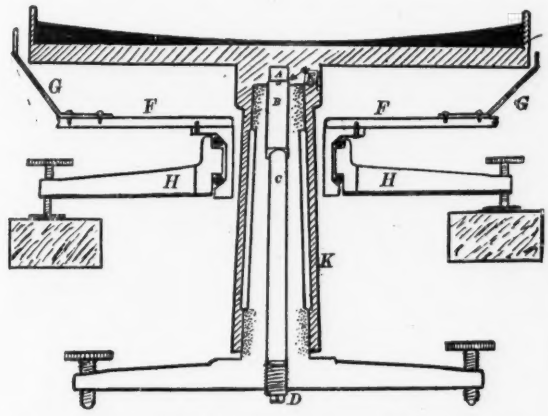

Fig. 1.—Diagram showing mercury surface, insulated iron basin containing it; and rotating mechanism.

magnets fastened to a dish of mercury around with them. The "rotor," as the outer ring of magnets may be termed, was mounted on a support which was quite apart from the mercury basin and *its* support. Consequently any jars experienced by the "rotor" or outer ring were not communicated to the inner ring of magnets or to the dish holding the mercury.

The first experiment was so promising that it was set up at East Hampton for further investigations. The seven-inch instrument was in the form of a circular disc surmounting a short cylindrical pillar conical at the end. The disc was turned out into a shallow, flat-bottomed basin, and the whole was supported on a steel cylinder turned to a cone at the top—the construction being similar to that adopted in the turn tables made for finishing microscopic slides. With this instrument there were four distinct sources of ripples:—

(*a*) Jars from the driving mechanism, *i.e.*, motor, speed-pulleys, etc. These were eliminated by the magnetic clutch previously described.

(*b*) Jars due to the grinding together of the bearing surfaces of the mercury basin itself. These were always present in the first instrument as the surfaces were not polished. It was hoped that better workmanship would eliminate them, as was found to be the case.

(*c*) Imperfect levelling of the instrument, which sets up a sort of tidal wave; easily overcome provided the axis of rotation is accurately perpendicular to the flat bottom of the dish.

(*d*) Variations in the velocity of rotation, which give rise to very troublesome waves.

The construction will be understood by reference to Fig. 1. The top part is the iron basin with the surface of mercury. Into this was inserted a plug A of hardened steel. This plug rested on a second plug B, which could be raised or lowered by the screw C, turned by the nut D. The weight of the basin was carried by the steel plugs, but there were two conical bearings to keep it level, and by lowering the screw C the weight could be thrown on them.

The driving mechanism or "rotor" was the large wooden pulley FF carried on the tripod HH, which was supported independently of the rotating basin. First of all magnets conveyed the motive force from the pulley system to the basin above, but ultimately fine elastic threads of rubber fastened to the brackets GG—(six in number) and attached to the rim of the basin—were found to do equally well and did not transmit jars.

Preliminary experiments were made with the instrument mounted on a brick pier, and, as it was found that nearly everything depended on accurate levelling, special care was given to this point. A Nernst lamp with its filament vertical was mounted on the ceiling of the laboratory at a height about 12 feet above the mercury surface. At a speed of rotation of about one turn in 3¾ secs. the image was formed at a part where it could be reached easily and examined by standing on a ladder. If a sheet of paper was held a few inches below the focal point the circular ripples were clearly visible. The bright centre of the ripple system did not, however, coincide with the centre of the convergent cone of rays. By turning the levelling screws it could, however, be brought accurately to the centre, which gives a first approximation to the true level desired. The ripples became much less conspicuous as soon as this operation was performed, and it was speedily discovered that they were in large part due to a sort of tidal wave resulting from imperfect levelling.

With the instrument in approximate adjustment the surface appears perfectly smooth and free from ripples. "One thing," writes Mr. Wood, "which struck me as especially interesting was the slowness with which the velocity of the dish was communicated to the fluid. The mercury picks up its velocity first at the rim, a circular zone of constant velocity and focus crawling in gradually from the edge toward the centre. If the eye is placed above the centre of the dish a little above a focus, one sees a narrow ring of light of dazzling intensity converge gradually from the rim toward the centre. It required over two minutes for all parts of the fluid mass to acquire a constant angular velocity.

The appearance of the room as viewed in the mirror while it is getting up speed is very striking. The rafters of the roof recede to an enormous height and the whole room appears to expand in a most remarkable manner. The appearance of the mercury surface in rotation, and its freedom from ripples are shown in

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Fig. 4. The distortion of the reflected image is, of course, due to the astigmatism which results from oblique incidence.

After completing the preliminary experiments in the laboratory, preparations were made for mounting the instrument below ground. An old well-house adjoining the barn was transformed into an observatory, a new floor being laid and a large scuttle cut in the roof. The brick well, which was no longer used, was filled up with large granite blocks and Portland cement to a height of about two feet above the water level, after which it was lined with cement, forming a water-tight pit about 14 feet deep and 30 inches in diameter. The granite and cement bottom formed a very solid foundation for the mirror to stand upon. A second pit was sunk about six feet from the well, just outside of the well-house, and the two put in communication by means of a tunnel at the bottom. It was the original plan to drive the mirror by means of a pulley-belt running down the side of the cement pit, but as it was found that it was necessary to make very precise adjustments while the mirror was running, the second shaft became necessary. The mirror was mounted upon three blocks of cast-iron which rested on the cement floor, and the driving mechanism or "rotor" was carried upon a wooden *I*-beam which passed under the floor of the tunnel and was securely anchored to brick piers in the second pit. The electric motor, driven by a 110-volt alternating current, and the speed-pulleys were mounted in the second pit, the belt passing under the floor just above the *I*-beam and around the wooden pulley of the "rotor." The tunnel was lighted by an electric lamp.

The general arrangement of the apparatus is shown in Fig. 3. It will be seen from the diagram that the slight jars from the "rotor" can reach the revolving mirror only by passing back to the second pit along the *I*-beam, thence through the brick piers and back through seven or eight feet of sand to the massive granite foundation. It is needless to say that they were quite imperceptible at the end of their journey.

Within the well-house and close to the mouth of the pit a vertical wooden cylinder was mounted with a horizontal arm carrying a plate-holder. A photographic plate could, by means of this simple device, be held fixed in any position above the pit, for making star trails. Visual observations were made by standing at the mouth of the pit, or upon the roof of the house, according to the focal length used, and holding an eyepiece in the hand.

"At the time when the experiments were commenced the Milky Way was in the zenith at nine o'clock, and its appearance when I observed it from the roof of the house the first time the motor was started amply repaid me for all my trouble. No eyepiece was used, the star images appearing in space about three feet above the mouth of the pit. They appeared perfectly sharp and quite steady, since the cone of light entering the pupil of the eye under these conditions comes from but a small part of the mirror's surface. On examining the images with the eyepiece it was at once seen that the focus changed periodically through a range of, perhaps, an inch and a half. On viewing the images in space with both eyes they were seen to be rising and falling rhythmically, dancing up and down like will-o'-the-wisps. There were moments when they were quite sharp in the eyepiece, but even then they were not quite stationary, moving about in a sort of Lissajou figure, perhaps a millimetre in diameter. The nature of the disturbance on the mercury surface could be detected by placing the pupil of the eye in coincidence with the star image."

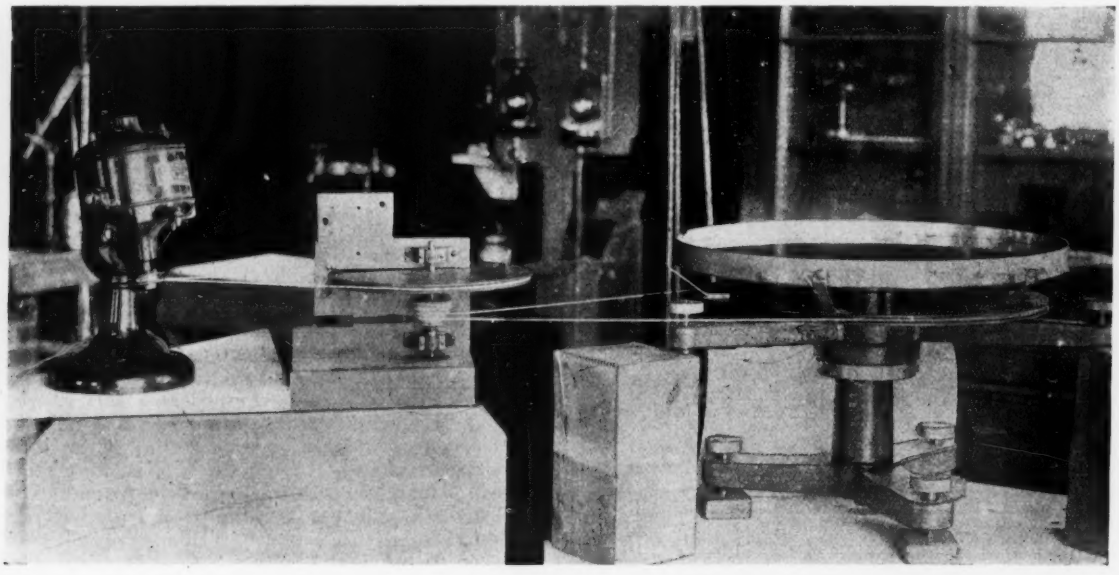

Fig. 2.—Photograph of iron basin and rotating mechanism.

It was at last found that these ripples were due to slight periodic variations in the velocity of rotation which caused a "slip" between the mercury and the iron rim of the basin. The periodic change of focus was due to the slight variation of the velocity occurring at each revolution; but it is possible that in the better construction this variation may be eliminated.

In a few remarks about what the instrument is capable of, Mr. Wood says that with it he had no trouble about separating some of the double stars 5″ or

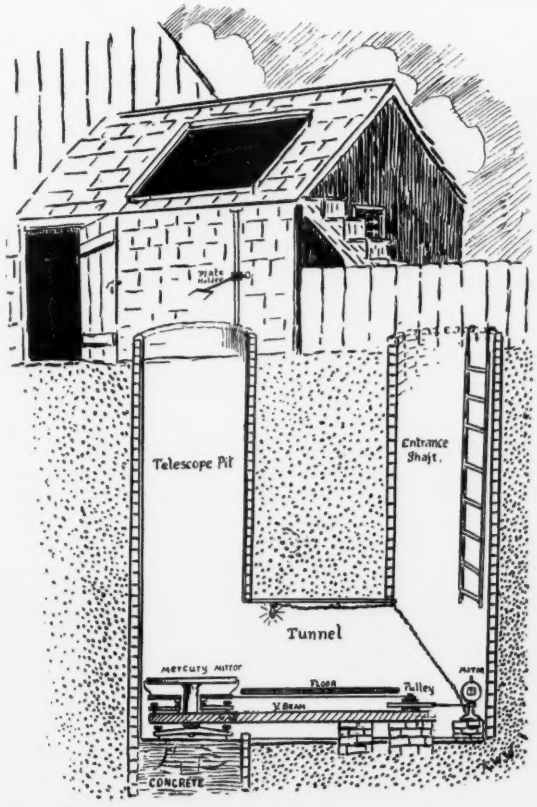

Fig. 3.—Plan of arrangement of mercury surface telescope in and under cottage.

Fig. 4.—Mr. Wood reflected in surface of rotating mercury.

6″ apart, and once he had momentary glimpses of the revolution of both ϵ_1 and ϵ_2 Lyræ. He had some splendid views of nebulæ almost as good as in a large refracting telescope. Mr. Wood concludes: "I have not as yet convinced myself that the mercury telescope will be of use in astronomical observations, even if it is possible to bring it to a high degree of perfection. Its great disadvantage lies in the fact that its observations are confined to a narrow region surrounding the zenith. On the other hand, it has the great advantage of a focus which may be made to vary over as wide a range as we please, and its cost is very small. The 20-inch instrument, with its motor, cement pit, entrance shaft, tunnel, etc., cost only 200 dols., not including the mercury. In the case of small instruments, not over three feet in diameter, it may be feasible to use an auxiliary plane mirror driven by clockwork or by hand, for reflecting the light from any part of the sky to the bottom of the pit. An instrument of large size could in this way be placed within the means of any amateur observer, and valuable data might be secured. Whether a gigantic reflector mounted in a suitable latitude would enable us to see more of planetary detail I do not feel prepared to say. We could in this way combine great focal length and immense light-gathering power, but we should still have the atmospheric disturbances to contend with."

THE French physicists Bethisy, Fonchard, and Vignes are said to have succeeded in making an incombustible substitute for celluloid. The material is made from tetranitrocellulose, containing about 40 to 45 per cent. of water; a product of a liquid hydrocarbon. After thorough mixing of the mass, the water is expressed therefrom, and the remaining material changed, by treatment with albumen, vinegar, ether, acetone, amylacetate, and alcohol, into a plastic mass. After standing twenty-four hours it is worked into rods between hot rolls, until it is of a firm consistence; is then cooled, and next denitrized by suitable means. The working with rollers is then repeated, and the sheets thus obtained are worked for six hours in a steam chamber under a hydraulic pressure of 150 atmospheres (2,250 pounds per square inch). The pressure is then increased to 200 atmospheres; and instead of steam, cold water is employed. This process brings the material into the form of very hard blocks, which are then cut into sheets and dried. In order to make tubes, rods, etc., the material is shaped in suitable moulds.

AN electrical anemometer has recently been devised which is based on the fact that the resistance of platinum varies in proportion to its temperature. Prof. R. B. Goldschmidt, of the University of Brussels, is the inventor of this apparatus. It consists of two wires, one of which is exposed to the wind, while the other is shielded from currents of air, but yet is subject to the surrounding temperature. The wires form two branches of a Wheatstone bridge, and the galvanometer connecting the bridge is not affected when there is no wind, as the temperature of the two wires must remain the same whether the surrounding temperature rises or falls. In case of a current of air striking the wire, there will be a difference of temperature which will be recorded by the galvanometer. The direction of the wind is indicated by a recording weather vane, which is used in connection with the anemometer.

Some Curious Facts in the Distribution of the British Newts.

By BRUCE F. CUMMINGS.

SOME curious facts in the geographical distribution of the three British species of tailed amphibians have recently been brought to light. Modern investigations have proved that the well-known statements in regard to this subject which have been copied and re-copied in almost all the English works of Natural History, to the effect that the Greatcrested Newt (*Molge cristata*) and the Common Newt (*M. vulgaris*) are generally common and that the little Palmate Newt (*M. palmata*) is very rare and has only been found "near Bridgwater, the Isle of Wight, and near Reading," are not only misleading but quite incorrect.

The real facts, as recently elucidated, are these. The Palmate, so far from being rare, is very widely distributed. It is found from Cornwall to Sunderland and from Anglesea to the Isle of Wight. This conspicuous and handsome little species, with webbed hind feet, is the *only* species recorded from Cornwall, where it is very common. In Devon, too, the Palmate can be found in every pond and roadside runnel, while the Common Newt is absent, and the Greatcrested, until a short time ago, was thought to be absent likewise. Some few months since I discovered the latter species in a pool in North Devon, but before that time no authentic Devonshire specimen existed in collections. In Somerset *M. cristata* appears frequently, but is local, while as far up as Gloucester, the Palmate begins to grow local as well. Turning to Wales, it is important to notice the same conditions prevailing as those in the S.W. Peninsula, viz., the occurrence of the Palmate form to the almost total exclusion of the other two. As to the rest of England and to Scotland, the Palmate Newt is generally common but local; it has been recorded from a large number of counties, and also from Anglesea, Bardsea Island, the Isle of Rum, and the Isle of Wight; there are no newt records either from Lundy or the Scilly Islands. Professor Jas. Clark informs me that he has seen no Newt alive on the Scilly Islands, but there is, in his possession, a specimen of the Palmate species, which was captured by a resident on St. Mary's, near Porthellick Bay. On the other hand, Mr. T. A. Dorrien Smith, who was good enough to make careful enquiries for me, was unable to find any evidence of the existence of newts on the islands. Ireland possesses only one species and that, contrary to all expectation, proves to be *M. vulgaris*. Dr. R. F. Scharff has found it, in its typical form, in about 20 localities N., S., E., W. Reported occurrences of two species have always been founded on the sexual differences in the Common Newt.

Fossil remains are very scanty, bones, which are referable to the Greatcrested species and were discovered in the Forest Bed, appear to constitute the sole record. With such conflicting evidence as this, it seems to be quite impossible to decide which species is, phylogenetically, the oldest. According to the evidence of palæontology *Cristata* is the oldest, according to distribution in Great Britain and its occurrence on several outlying islands we should be led to expect *Palmata*, then Dr. Scharff's report from Ireland arrives and makes the problem a three-cornered one; for it is safe to assume that, during the time of the hypothetical connection of Ireland with England, *M. vulgaris* was the only species existing as it was the only one to cross the boundary into Ireland. It should therefore be the oldest.

The more remarkable facts, in connection with the distribution of these little amphibians, are to follow. It is now agreed on all hands that *M. palmata* is exceedingly common in Devon and Cornwall, the Common Newt absent, and the Greatcrested almost unknown. But all the older naturalists in the two counties were agreed in recording *Cristata* and *Vulgaris*, but *Palmata* only rarely. Thus the late Mr. Brooking Rowe, in a letter to Mr. E. E. Lowe (a former curator of the Plymouth Museum), which was published in the "Victoria Co. Hist. Devon," says: "As to the Smooth Newt (*M. vulgaris*), I am surprised at what you say [that it did not occur in the county]. It was, without question, the common species some years ago and found everywhere. I was the first to record *T. palmatus*, and found it in a pond not far from here (Plympton)." We are driven to believe, either that the older naturalists failed to distinguish the obvious differences in the two species, or else, the more probable hypothesis, that within late years *M. palmata* has increased to such an extent that it has almost completely ousted the other two.

No less a person than the late Professor Edward Forbes (who was a Manxman) stated that "*T. palustris* and *T. punctatus* were by no means uncommon in their different habitats everywhere" on the Isle of Man. But no newts now exist there. If the older naturalists, with Professor Forbes, wrongly identified these newts, the former may gain a little consolation from the fact that they have sinned in good company.

However, I am strongly inclined to believe that for some considerable time past, the Palmate has been increasing in numbers, and widening its range to the prejudice of the other species. Its small size enables it to live in very small ponds and ditches, it has the widest distribution, and is the only species which is found in mountain pools. It would, therefore, seem to be able to stand greater variations in climate and environment. It is exceedingly unlikely that Professor Forbes should have made so glaring an error. It is easier to suppose that, in a succession of unfavourable years, when, among other things, an unusually small rainfall occurred, the two Manx species, *M. cristata* and *M. vulgaris*, became extinct on the island. The Palmate would be the most capable of withstanding these conditions, and would increase and multiply in other parts of the country, where, previously, it had already gained a footing. A careful study of newts in their natural habitats, over a series of years, affords convincing proof of a considerable rise and fall in the number of individuals of each species, in different seasons, which is, as often as not, quite inexplicable; at all events in terms of weather and climate. I think it highly probable that, on account of a recent supervention of a powerful combination of unfavourable conditions—just when, during one of these fluxes, the numbers were at the minimum—the Common and Greatcrested Newts have become extinct in many places, where they were once common, the result being that the hardier Palmate, left master of the field, has shot ahead and won in the struggle for existence. This increase (and the subsequent migration and dispersal which has occurred) presents a most interesting and unexpected phenomenon.

The Disinfection of Schools.

AN interesting experiment in school hygiene has been completed by Mr. W. H. Marsh, Staff Science Instructor of the Buckinghamshire County School. With a view to the prevention of infectious disease the floors of 25 schools have been sprinkled nightly during the past twelve months with a solution of cyllin, and the attendance in these schools compared with that of the schools in which the process was omitted. Mr. Marsh reports an improved attendance in the disinfected schools sufficient to earn additional grants amounting to over £50, the entire cost of disinfection for the twelve months being under £30.

The Earthquakes of Comrie, in Perthshire.

By Charles Davison, Sc.D., F.G.S.

At the present time, earthquakes are of somewhat rare occurrence in this country, though not so rare as many imagine, for in one part or another of Great Britain we are visited on an average by about one shock a month. Seventy years ago, however, they were more common, and the village of Comrie, in Perthshire, in particular, acquired a reputation for its earthquakes which, though it now rests on a slender foundation, has not completely died away. I propose in this paper to describe this period of seismic activity, of which but few witnesses probably remain, and also another period, the first known to us, which occurred about fifty years before.

Comrie lies in the valley of the Earn, twelve miles north-east of Callander and six miles west of Crieff, and therefore in the midst of some of the finest and best known scenery of Scotland. Ben Chonzie and Ben Voirloch, both rising to more than 3000 feet, are only a few miles away. Loch Earn is about four or five miles to the west of the village; while seven miles to the north is Glen Almond, the Glen Tochty of Ian Maclaren's novels. The river Earn runs close past Comrie, a few hundred yards on the southern side.

Towards the close of the eighteenth century there fortunately resided in Comrie an observer with scientific interests, the Rev. Samuel Gilfillan, who was in the practice of making notes of any shocks felt by him and of their accompanying phenomena—a habit which became so well known that it earned for him the title of the "Secretary to the Earthquakes." At Ochtertyre, four miles east of Comrie, there was also at this time another minister with similar tastes, the Rev. Ralph Taylor, who kept a record of his observations, and in addition made inquiries in the surrounding district. Extracts from Mr. Gilfillan's journal were given fifty* years subsequently to Mr. David Milne (afterwards Home), and published by him in a valuable series of papers in the *Edinburgh New Philosophical Journal*.* Mr. Taylor's letters were communicated to the Rev. Mr. Finlayson, and are to be found in the *Transactions of the Royal Society of Edinburgh*.† The value of either it would be difficult now to over-estimate.

On November 11, 1788, so far as known, Comrie received its first experience of the earthquakes which afterwards became so frequent. Vibrations from other centres must, of course, have been felt in the village before, and there can be little doubt that there had been previous local visitations which for want of observers remained unrecorded, but which were perhaps responsible for many a story of haunted houses. In the month of May, 1789, rumbling noises were reported from Killin, at the west end of Loch Tay, and towards the end of August slight shocks were felt at Comrie and one or two places in the immediate neighbourhood. But it is admitted that none of these sounds or tremors would have attracted more than passing attention had it not been for the stronger shocks that followed.

On September 2, however, at about 11 p.m., there came a shock that could not be mistaken. It was sensibly felt at Comrie, and at Ochtertyre there was heard a rumbling noise, which was taken at first to be that of a large table dragged along the floor upstairs. Many slight tremors and concussions followed during September and October—how many is unknown, for imagination was still held responsible for such rumours. But, on November 5, all doubts as to their reality were set at rest by a violent shock at 6 p.m., that was felt over an area 20 miles in diameter. "Some," says Mr. Taylor, "compared the noise which accompanied it to that of heavy loaded waggons dragged with great velocity along a hard road or pavement, and thought that it passed under their feet. To me [at Ochtertyre] it seemed as if an enormous weight had fallen from the roof of the house, and rolled with impetuosity along the floor of the rooms above; and it must have made a similar impression on the servants, for some of them instantly ran upstairs to discover what had happened. Others were sensible of a tremulous motion in the earth, perceived the flames of the candles to vibrate, and observed the mirrors and kitchen utensils placed along the walls to shake and clatter. There is also reason to believe," he adds, "that the waters in the Loch of Monivaird, in the near neighbourhood of Ochtertyre, suffered unusual agitation, as the wild fowl then upon the loch were heard to scream and flutter." At Comrie and other places within a short distance, the shock was more violent and the accompanying noise more alarming. "The inhabitants of these places . . . declared that they perceived distinctly the earth heaving under them, and the motion communicated to their chairs and other furniture. They imagined that the slates and stones were tumbling from their houses, and many of them ran out in the greatest trepidation from the notion that the roofs were falling in. Even the domestic animals were alarmed, and contributed by their howls and screams to increase the terror of the people." This shock was succeeded by a number of rumbling noises like those heard during the previous months. Not less than thirty, it is said, were counted within the next two hours, but it was noticed that they were not in any case heard far from Comrie.

Five days later, on November 10, another shock of about the same character and strength was felt at 3 p.m., this time as far as Crieff. "It was a market-day at Comrie; and the people, who were assembled from all parts of the country, felt as if the mountains were to tumble instantly upon their heads. The hardware exposed for sale in the shops and booths shook and clattered, and the horses crowded together with signs of unusual terror." On the following morning, there was still greater reason for dismay. A third and more violent shock was felt from Killin on the west to Glen Almond on the east. So strong was it that the ice on the sheet of water near Lawers House was shivered to pieces. After this the disturbances became less frequent, and for several years, though they did not quite die away, none was sufficiently strong to cause alarm, or even to attract much attention.

The most interesting feature about the earthquakes of 1789 is the great number of slight tremors and rumbling noises that were observed, chiefly at Comrie. Writing in the following January, Mr. Taylor remarks that, on a moderate computation, there cannot have been fewer than eight or nine hundred noises or concussions heard within the preceding six months. A second point, and one of some significance, which he notices is the extremely limited area to which the disturbances were confined. With the exception of the stronger shocks, such as those to which reference has been made, no tremor or noise was noticed at a greater distance than three miles from Comrie. They were often felt or heard as far as Lawers on the east (see the accompanying map), in Glen Leadnock to the north, at Dunira, Dalchonzie, and Aberuchill on the west; but, towards the south, they were rarely, if ever,

* Vol. 31, 1841, pp. 108-12', 259-309. † Vol. 3, 1794, pp. 240-246.

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observed at the manse of Comrie, which lies only three-quarters of a mile from the village. Strong as they were at Comrie itself, the river Earn seemed to interpose a barrier beyond which they could not pass.

Early in 1791, Mr. Taylor left Ochtertyre, and thereafter our records are chiefly confined to Comrie. Two years later, however, he made a brief visit, and reports that rumbling noises or slighter concussions were still occasionally observed. During 1794 and 1795, the "Secretary to the Earthquakes" chronicles several shocks and many uncounted rumbling noises. The next five years were marked by occasional disturbances at Comrie, but by none of any considerable strength. But with the beginning of the century there came a change, and the Comrie earthquakes acquired more than a merely local celebrity. On January 11, 1801, two violent shocks occurred, one at 7 a.m., the other after 11. A loud noise was heard, and the scene, it is said, was very awful. One of these shocks was felt at Callander, Perth, and Grangemouth, even as far as Edinburgh, from which Comrie is distant more than forty miles; but we have no further details. For the next eight months the "Secretary's" journal is silent, until September 6, when a "great" shock accompanied with a very loud sound took place, and was followed by a slight shock and subterranean noises. The next day, two more shocks were felt, at 4 and 6 a.m. The latter of these, according to Mr. Mallet, the well-known seismologist, was felt over nearly the whole of Scotland. Sleepers rushed from their bedrooms, and met in passages in their night-clothes, thinking their houses were falling about them. In Edinburgh people felt their houses lifted up, and it is reported that "two reapers near Edinburgh were killed, and a third was bruised, by the gable of an old barn falling on them, which was thrown down by the shock. A large tenement in Paterson's Court (Edinburgh) sank so much as to require being abandoned by its inhabitants, and it was ordered by the magistrates to be pulled down." If, however, the origin of this shock was at Comrie, as appears to have been the case, it is, I think, very doubtful whether the earthquake can be held responsible for such damage at so great a distance from the centre.

In the course of about a quarter of an hour, this great shock was followed by about twenty subterranean noises. Others were heard in succeeding months, and occasionally a shock or two was felt; but, on the whole, a lull that lasted for thirty-eight years supervened, during which the seismic powers were almost inactive. They were only temporarily exhausted, however, and were in fact gathering strength for another and more prolonged outburst in 1839.

By this time the journal of the venerable "Secretary" had long ceased to be written up, though it was provided with a successor in the more scientific and elaborate diary of the village postmaster, Mr. Macfarlane. Encouraged by the enthusiasm of Mr. Home, to whom we are indebted for the permanent record of these interesting phenomena,* Mr. Macfarlane gave them the closest attention. He did much more than merely register the times at which they occurred. He devised and constructed instruments, of what kind we are not told, that would continue the work during his hours of rest or absence. By means of a rough scale of intensity, ranging from 1 for the weakest shock to 10 for the strongest (that of October 23, 1839), he also contrived to give more precision to his estimates of their strength than any descriptive words would convey.* There were also other observers. Mr. James Drummond, a shoemaker, kept a record, the published portion of which† makes one regret that it was not maintained for a longer time and accompanied by others in different places. All round Comrie, there were fortunately many residents who took more than a passing interest in their local wonders, with the result that Mr. Home was enabled to give a more detailed account of the earthquakes of this period than we possess of any previous British shock.

A further sign of the interest aroused by the Comrie earthquakes was the appointment in 1840 of a Committee for their investigation by the then youthful British Association. Mr. Home was the Secretary of the Committee, which included then, or afterwards, such useful coadjutors as Professor J. D. Forbes and Professor Buckland. The primary object of the Committee was to obtain instruments for recording the earthquake-shocks, and this object they certainly fulfilled to the best of their ability. By the end of 1840 one pendulum had been erected at Comrie (in the spire of the parish church) and two others in the immediate neighbourhood, and these were followed by five more within the course of another year. The records of these instruments proved, unfortunately, to be of little value. The pointers were occasionally disturbed as much as half-an-inch, but it by no means follows, as seems to have been then supposed, that to these displacements corresponded an equal movement of the ground. Moreover, they were far less sensible to earthquakes than were human beings. During the first six months in 1841, for instance, they registered only two of the 27 shocks that were distinctly felt at Comrie. But it is not to be supposed that the labours of the Committee were thereby wasted. During its four years of office, it encouraged the observation of the earthquakes, and, when the Committee ceased to exist in 1844, interest in the subject also began to fade away.‡

The early warnings of the coming shocks that were given in 1789 were repeated in a similar manner fifty years later, in 1839. On October 3, there was a slight shock, of intensity 2, according to Mr. Macfarlane's scale. On the following day Mr. Drummond heard a sound which he likened to, and indeed called, a "gas-explosion." After this shocks and sounds became more frequent. During the first three weeks of October, Mr. Macfarlane records more than forty shocks, and Mr. Drummond more than thirty "gas-explosions," all leading up to, and preparing the way for, the great shock which occurred at about 10.30 p.m. on the 23rd. If we may judge from the accounts given by Mr. Home, this shock must have been sufficiently alarming in its character. "The sensation conveyed to me by the concussion," writes one observer at Comrie, "as I was standing on the ground floor, was as if the earth was being rent asunder under my feet; and this for some seconds I fully expected to happen, from the violent movement, apparently in the bowels of the earth." The sound, according to another, was "indescribably terrific"; it was louder than thunder and seemed to be combined of the noises made by water, wind, thunder, discharge of cannon, and the blasting of rocks, all taking place together. In the neighbourhood of Comrie, about twenty houses were more or less damaged, chiefly to the east and west of the village.

Edinburgh New Phil Journ. Vol 32, 1842, pp. 106-127, 362-378; Vol. 33, 1842, pp. 372-388; Vol. 34, 1843, pp. 85-107; Vol. 35, 1843, pp. 137-160.

* This is, I believe, the first scale of seismic intensity ever devised.

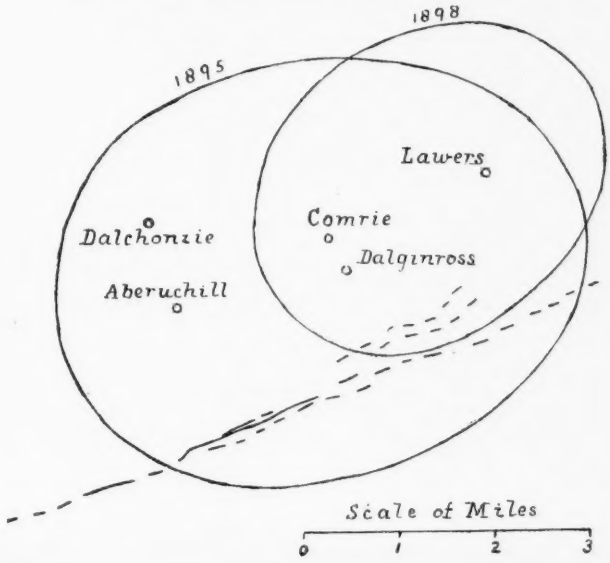
† *Phil. Mag.*, Vol. 20, 1842, pp. 240-247.

‡ Brit. Assoc. Reports, 1841, pp. 46-50; 1842, pp. 92 98; 1843, pp. 120-127; 1844, pp 85-90.

In great, but by no means excessive, detail, Mr. Home describes this important shock and its manifestations in different parts of the disturbed area. In summing up, he draws some interesting conclusions. The movement of the ground, especially near Comrie, he remarks, consisted of several distinct and successive undulations, followed by a general quivering; at more distant places, the trembling alone was observed. The movement took place almost simultaneously throughout the whole area affected; at any rate, the velocity of the earth-waves was so great that ordinary clocks and watches could not be trusted to determine any difference in the time of occurrence, whether at places near to, or far from, Comrie. There can be no doubt that the shock was felt throughout at least two-thirds of Scotland. The southern limit Mr. Home places as nearly coincident with a line drawn from the Solway to the mouth of the Tweed; the northern limit, with the line of the Caledonian canal, running from Inverness to Loch Linnhe. But what appears now as his most significant conclusion is the fact that the isoseismal lines, or lines of equal intensity (the construction of which he does not explain), "appear to have formed ellipses, of which Comrie is the centre, and of which the longer diameter is about north-east and south-west, or parallel with the chain of the Grampians."

To refer at all fully to the numerous shocks and sounds that followed the great earthquake would require many pages. During the remainder of the year Mr. Macfarlane enumerates 66 shocks, 71 in 1840, 77 in 1841, 27 in 1842, 22 in 1843, and 26 until September, 1844—altogether 334 shocks within the space of five years. Mr. Drummond's list is no less full. During the last three months of 1839 he registers 124 earth-sounds or "gas-explosions," 99 in 1840, and 53 in 1841. With the year 1844 the British Association reports as well as Mr. Home's valuable papers ceased to appear. The catalogues of earthquakes afterwards published annually by Professor Perrey, of Dijon, show that Mr. Macfarlane continued to attend for several years to the shocks which he had studied so unweariedly. But there can be no doubt that after 1844 the earth's crust in the neighbourhood of Comrie was returning to that condition of repose which, except at somewhat wide intervals, it has maintained ever since.

During the last nineteen years this state of comparative rest has, so far as I know, been broken on only three occasions. On July 12, 1894, a very distinct trembling, accompanied by a dull, rumbling sound, was observed at Comrie. A year later on July 12, 1895, a somewhat stronger shock was felt over an area 5½ miles long, 4¼ miles wide, and containing 18½ square miles. The centre of the area is situated a quarter of a mile south-west of Comrie, and the longer axis runs about east-north-east and west-south-west. Lastly, on August 22, 1898, a very slight tremor was felt at one or two places (though not at Comrie), while a rumbling noise was heard over an area of about 9 square miles, the centre of which is about a mile east-north-east of Comrie.



With regard to the origin of the Comrie earthquakes, we learn as much, if not more, from the numerous slight shocks as from the two or three strong ones felt over a wide area. We see, first, that the majority were confined to very limited districts in the immediate neighbourhood of Comrie and seldom extending south of the river Earn. Secondly, notwithstanding the smallness of the areas disturbed, the intensity of the shocks was often rather great (at any rate, sufficient to cause considerable alarm) close to the centres of these areas, and died off rapidly towards their boundaries. From these two phenomena, we infer that the origins of the tremors were situated at a very small depth and were of comparatively small size. Thirdly, taking into account the magnitudes of their disturbed areas, the more important shocks were by no means unusually strong at Comrie; from which it may be concluded that the foci of these earthquakes were situated at a somewhat greater depth. Lastly, and this is one of the most significant points of all, the longer axes of the isoseismal lines of the earthquake of 1839 were directed approximately north-east and south-west, the axis of the disturbed area of the slight shock of 1895 is directed east-north-east and west-south-west; while the centre of the area affected by the earthquake of 1898 was about a mile and a quarter east-north-east of that of the earthquake of 1895. It follows from this, that the origins or foci of some of the earthquakes were not mere points, but were regions elongated in a direction from east-north-east to west-south-west; and further that the foci were not fixed, but were liable to a displacement in the same direction.

Now, if we look at a geological map of Scotland, such as that prepared by Sir Archibald Geikie, we notice that, running right across the country in a south-westerly direction from Stonehaven, is a great fault which passes about a mile to the south of Comrie, its general direction in that district being exactly east-north-east and west-south-west. Along this fault the rocks have suffered an enormous displacement; for on the south-east side are formations belonging to the Old Red Sandstone, while on the north-west side the rocks belong to the Lower Silurian. From the geological evidence, it is probable, though not certain, that the fault is inclined to the north-west.

How long this fault has been in existence it is unnecessary for our present purpose to know. What we are concerned with is the manner in which the rocks on one or both sides have been displaced. We cannot conceive that the movement occurred throughout its whole extent at once. It must have been produced by slips, here a little and there a little, not concentrated in one period, but prolonged throughout a time which, even geologically speaking, must be considered vast. When a slip, however small, took place, the rock on one side must have ground heavily against the other, and, owing to the intense and sudden friction thus brought into action, vibrations must have been propagated outwards in all directions. At the surface, these vibrations would be sensible to human beings partly as a shaking, partly as a deep rumbling sound—in other words, as an earthquake-

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shock. And, when we consider the nature of the Comrie earthquakes, the position of the disturbed areas on the north-west side of the fault, the elongation of those areas and their occasional displacement, both in the direction of the fault, it is difficult, I think, to resist the conclusions that the growth of this fault is not yet at an end, that slips are still taking place, a few at a depth perhaps of two or three miles, followed by the vast majority which are hardly more than creeps and much closer to the surface, and further that these small slips or creeps have given to Comrie its well-known character as the most unstable district in Great Britain.

An Extraordinary Meteor.

By W. F. DENNING.

THERE are all sorts of meteors, large and small, swift and slow. Some take very extended flights, others dive down in short quick courses. Some have trails of yellow sparks accompanying them, another kind evolve the phosphorescent streaks which are an almost invariable feature of the Perseids of August and Leonids of November.

It is questionable if a more unusual meteor than that which appeared on Feb. 22 last at 7.30 p.m. has been presented in our atmosphere for many years. Nor has one been observed which has attracted more widespread attention and has been more effectively and accurately recorded. Fireballs, it is true, are comparatively numerous, but they are often not well seen, for their luminous careers are over in a few seconds. Bursting out with vivid effect they flood the sky with light, but are generally gone before spectators recover from the surprise occasioned by the suddenness of the unexpected apparitions.

But the meteor of Feb. 22 last was far from being so fugitive in its visible aspect, for its streak remained in the sky for about 2½ hours. In fact the streak or afterglow was more remarkable than the actual meteor, for while hundreds of people observed the flight of the object thousands remarked the beautiful and variable ribbon of light which it dispersed across the firmament. During the long period that it continued in view, it moved from the stars of Canis Minor, Monoceros, Orion, and Canis Major to the region of Ursa Minor, Cassiopeia and Cepheus, where it ultimately became more diffused and could not be distinguished from the Milky Way.

The meteor itself was a Comæ Berenicid from 190° + 20°, and it traversed a long flight E.N.E. to W.S.W. over the English Channel at a height of from about 56 to 41 miles at moderate speed. Meteors from a radiant in such a position relatively to the direction of the earth's motion seldom generate streaks, but leave trails of reddish or yellow sparks immediately in their wake. But the meteor of Feb. 22 was an exception. It exhibited the customary train, which quickly died away; then a whitish streak strikingly developed all along the path, and formed quite a conspicuous aspect. People looking casually up to the sky saw the beam of light at once, and could not help remarking its unusual aspect. Its position with regard to the stars was delineated by many of the observers, but in some instances they were very discordant, and photographs, could they have been secured, would have been much more satisfactory. The ends of the streak appeared bent, and at about 8.10 to 8.30 the main beam was fully 100 degrees in length as estimated by several reliable persons. Parts of the streak drifted north-west at a rate varying from about 70 to 90 miles per hour—without any great change in its altitude above the earth's surface.

The length of its duration, its changes of form, and displacements in position are perhaps more notable than has ever been observed in connection with any other meteor in modern times. When the data are thoroughly sifted some interesting and important deductions may possibly be made concerning this class of phenomena.

A spectator in Bournemouth says the meteor was accompanied with a whizzing noise during its flight. Several persons in Kent aver they heard a hissing noise, and that as the object finally exploded they distinctly heard the reverberation. But as these sounds are stated to have been audible simultaneously with the meteor's descent they could have had no connection with the phenomenon. An observer on the south coast relates that after the meteor burst "a sort of powder fell," but there is no evidence to support this statement. At Bournemouth the lingering streak was described as being similar to "a brushful of starlight from the Milky Way drawn across the sky."

The radiant point at 190° + 20°, about 3° S.W. of the star 35 Comæ Berenicis, from which the meteor appears to have been directed, does not form the centre of a well-known meteoric shower. Ordinary shooting stars have radiated from the point in February, March, and April, but apparently the stream is a feeble one with no special characteristics. Some of these tenuous systems commonly yielding small meteors are, however, known to furnish occasional fireballs of the largest and most brilliant type. Thus on July 28, 1908, I saw a vivid flash from a splendid fireball situated over the east coast of Ireland, and directed from a radiant at 302° + 22° in Vulpecula. Yet though 12 other meteors were registered from this stream they were generally very small, not one being brighter than 2nd mag.

The Face and How to Read It, by Annie Isabella Oppenheim (London: T. Fisher Unwin, 1906; 2s. 6d. net).—This book is divided into two parts. Part I. consists of Scientific Character-Reading from the Face, based on anatomical values. Part II. of Physiognomical Studies of well-known men and women of the day. Madame Oppenheim in her chapter on anatomical values, speaks of the "various ingredients of which the human being is composed." We were heretofore under the impression that such a method of expression would be more applicable to the contents of a pudding. "The brain," she states, "is situated at the top part of the head, and extends downwards towards the throat at the back"; this description would hardly pass muster for accuracy in an elementary school. We are quite willing to concede that the study of the face is a fascinating one, depending much on the face, but how often are we deceived; indeed, how often has the author herself been deceived in her readings? When we consider that the shape of the head and facial lines are often largely determined by infantile rickets or specific disease, etc.; the shape of the nose or even the curve of the nostrils by the presence of adenoid growths, and so on; and that improper feeding, poverty, alcohol, and environment all play their parts in building up the human constitution and in shaping our anatomical structure; how, then, can we be certain of our phreno-physiognomical prognostications by the anatomical landmarks an individual possesses? We may make some shrewd guesses, that is all; there can be no information of scientific value gained by the observation of physiognomical characteristics or phrenological bumps. The physiognomical studies with portraits of well-known personages complete the book. The studies are interesting and amusing as efforts of character delineation based, no doubt, on hearsay and other contact evidence. The portraits are excellent. The book is recommended to all who would wish to learn how character-reading is managed.

Photography: Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Reduction Phenomena.

It is an undoubted fact that certain reagents that will reduce (or thin down) the image on a photographic plate behave differently from other reagents in this matter. Some reducers apparently dissolve away the image as they penetrate the film, and therefore remove the thin deposits that lie near the surface while the denser deposits that extend deeper into the film are only partially affected, while others thin down the denser deposits and appear to have little or no action on the deposits that are less dense and more superficial. This difference remains to be accounted for. A. P. H. Trivelli suggests that as the developed and fixed image consists of metallic silver plus a little silver halide or subhalide, there will be more silver halide (or subhalide) in the less dense parts, as there the hyposulphite has had more silver halide to dissolve in the fixing, and is consequently more weakened (or its "concentration" is more reduced) than in the denser parts of the image where a greater proportion of the silver halide has been reduced to metal during development. The thinner parts of the image would therefore be more resisting to the action of such a reducer as ammonium persulphate, which is not able to attack the silver halide, like those reducers that contain thiosulphate or thiocyanate or the equivalent. But this suggestion is not in agreement with the observation of Dr. Scheffer (see this Journal for last August) that if a part of the dense portion of an image is removed by dissolving the gelatine and is then formed into a thin layer, and this thin layer is subjected to the action of ammonium persulphate along with the original dense layer, the original dense deposit is considerably reduced before there is any apparent change in the thinner layer. There seems hardly room for doubt that in this case the denser and the less dense deposits consist of the same material, the difference being in the disposition of the particles. Indeed, if there is a difference in the composition or character of the material in the two cases, one might well expect the thinner deposit to be the more attackable, not only because it has been more manipulated, but because the particles are less crowded together.

Tri-Colour Screens for Colour Plates.

To get a glass surface absolutely covered without overlapping with the three suitable dyes in such small patches that they shall be invisible as separate patches to the unassisted eye, or even under a slight magnification, is a problem that has engaged many minds. In the autochrome plate the surface is not absolutely covered with the dyed starch granules, and after flattening them a little, a black pigment is used to fill up the intervening spaces.

A method recently proposed by Szczepanik takes advantage of the fact that dyes in any given medium have a tendency under certain conditions to pass into a second medium that is brought into actual contact with the first. Basic dyes generally will leave a gelatine film for a collodion film if the two are in contact. Szczepanik therefore prepares three solutions of gelatine coloured suitably by means of basic dyes, evaporates these solutions, dries the residues, powders them, mixes the powders in the required quantities much as Lumières mix their dyed starch grains, and dusts the mixture over a plate coated with collodion, the film of which is not quite hard. The dyes gradually leave the gelatine particles and pass into the collodion film, and after a suitable interval the nearly colourless gelatine particles may be washed off the surface. Besides giving a bright-coloured, fine-grained plate, this method would appear to have the further advantage that there would be little or no tendency for the dyes to pass into the superposed gelatine film that carries the sensitive silver salt.

Messrs. Lumière have recently patented another method of preparing colour screen plates. They coat the plate with gelatine and stain it with one of the three dyes. A series of lines in a fatty ink is now ruled upon the plate, the spaces being about twice the width of the lines. These protect those parts of the dyed film that they cover while the plate is washed or otherwise treated for the removal of the dye. The plate is next put in a solution of the second dye, which is only absorbed where the film is unprotected. A series of lines is now ruled similar to the first, but perpendicular to them and about equal in width to the spaces between them. The plate is again treated for the removal of the dye, and when the uncovered parts are bleached, it is put in a solution of the third dye which can only be absorbed by the uncovered parts. Finally, the lines ruled in fatty ink are cleared off with a suitable solvent. It is obvious that this would give the same disposition of the colours as is found in the "Omnicolore" plates, a continuous line of one colour alternating with a broader line which consists of the two other colours in alternating rectangular patches.

Mr. C. L. A. Brasseur has patented the use of small spheres of coloured celluloid. He cuts small cubes of celluloid from sheets, or cylinders from threads, dyes them in batches of the required colours, and rolls them between plates until they assume an approximately spherical shape. The tiny spheres of the three colours are mixed in the proper proportion and dusted over a surface that has been prepared with an adhesive that has been allowed to dry. The particles being free to roll can easily be caused to cover the surface in a single layer. By warming or otherwise the adhesiveness of the surface is restored and the particles fixed. A film of not quite hard celluloid is placed on the coloured surface, and the whole subjected to heat and pressure. The spheres flatten out, more or less filling the spaces between them, and adhere to the film. The sheet that at first carried the coloured particles is removed by treating it with a suitable solvent of the adhesive. The result is a practically homogeneous film of celluloid that contains in itself an irregular mosaic of the three colours.

Another proposed method of getting the colours on a celluloid film is to form a relief pattern by hot-pressing it against a suitable engraved plate, and inking it up with a greasy ink. The ink is deposited only on the raised parts of the surface, and there forms a resist while the sheet is immersed in an alcoholic solution of one of the dyes. The dye is absorbed only by the depressed uninked parts. The ink is removed, and the process repeated for the second dye. The third dye is applied to the raised portion after the second inking has been removed, and finally the sheet is hot-pressed to get rid of the relief.

Received.

From Messrs. Taylor, Taylor, and Hobson their catalogue of Cooke lenses. These are now made in seven series, and so meet practically every requirement, and, considering their quality, at very reasonable prices. The "convertible Cooke" lens, which consists of two Cooke lens combined, though either may be used alone, has been reduced in price from nineteen to fifteen guineas. It gives a choice of three focal lengths, eight, fourteen, and twenty inches, and may be used on plates from half-plate to 15 × 12. The aperture of the complete lens is f/6·5, and of each component f/11.

XUM

Solar Disturbances During February, 1909.

DURING February there has been a considerable amount of activity, including three large groups. The longitude of the central meridian at noon on February 1 was 161° 27′.

Nos. 10, 11, 11*a*, 12, 13, and 14 all appeared in the previous chart, but continued on the disc in the early part of February.

No. 15.—Two pores, 14,000 miles apart, seen near limb on 9th, and continued until 11th.

No. 16.—Showed as a pore 10th, a curve of four 11th, and a solitary pore when last seen on 12th.

No. 17.—A spot, 6,000 miles in diameter on 10th which shrank away until 19th, after which faculæ marked its position until 21st.

No. 17*a*.—A group of spotlets, 52,000 × 18,600 miles in area, appeared on 12th; three of its members largely increased in size by 14th. The group grew in length to 88,000 miles, and its longest member to 20,000 miles in diameter. Its trail of spotlets outlined a great ellipse on 17th. The numbers decreased as it neared the preceding limb, only one spot and faculæ being seen on 22nd.

No. 17*b*.—A spotlet closely preceding a faculic vein, only seen on 12th.

No. 18.—Two pores 20,000 miles apart on 11th, one still visible on 12th.

No. 19.—A spot, 17,000 miles in diameter seen 12th to 24th, had a double umbra 15th and 16th, with evanescent pores near by 15th, 16th, and 18th. The greatest length of the group 37,000 miles.

No. 20.—A bent line of three pores, 30,000 miles long, only visible 13th.

No. 21.—A spot, 16,000 miles in diameter, seen February 20 till March 4. Three tiny pores south on 22nd, one south 23rd, and another south-east on 24th, alone after.

No. 21*a*.—A spotlet seen 21st till 24th.

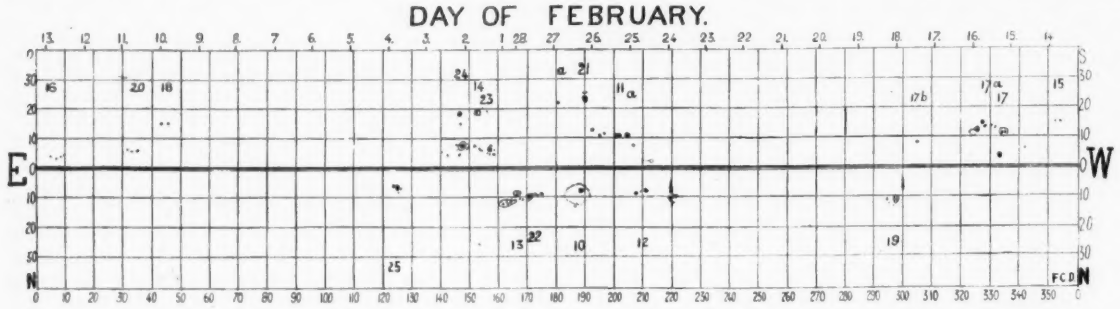
No. 22.—A spot, apparently a return of No. 13, about 14,000 miles in diameter on 22nd, near the limb, two spots on 23rd, and two elongated spots, with two pores, on 24th. On the 27th the direction of the spots had changed, although the longitude of the group was still the same as that of the original spot, but the length had increased to 45,000 miles. By the 28th it had extended westward, until its length was 104,000 miles. When last seen on March 5, the group covered an area nearly 140,000 × 37,000 miles in extent.

No. 23.—On 23rd only one spot seen, on 24th three; the numbers increased until by March 2 the entire group, including some pores following, had a length of 140,000 miles, but the chief disturbance was 120,000 miles long. One of the eastern spots had a diameter of 20,000 miles. February 23 till March 8.

No. 24.—A small spot, February 23 until March 2.

No. 25.—A small spot, its greatest diameter 14,000 miles, seen 27th, two pores south-west on 28th, two north-west on March 2. On 4th and 5th two spots, tiny pores 37,500 miles following on 5th, alone after, but amid a deal of faculæ within western limb on 8th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett.



CORRESPONDENCE.

A Plant-Life Conundrum.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The phenomenon described by Mr. Clarke-Nuttall on p. 96 is not confined to the plant in question—which, by the way, appears to be a specimen of the shining crane's-bill (*Geranium lucidum*), the one most commonly found on walls—nor even to geraniums in general, for, as an amateur gardener as well as something of a field botanist, I have noticed it in the case of sundry other species, of which, I regret to say, the only one I can call to mind at present is the common butterwort (*Pinguicula vulgaris*). Strictly speaking, there are two phenomena to consider, viz.: (1) The upward tendency of the inner leaves, and (2) the downward tendency of the outer. It seems to me that these two tendencies are independent and unconnected. I suggest that there is no doubt that the upward stretching of the inner leaves is merely the natural turning towards the light, or best light, which is characteristic of young and growing stems, shoots or leaves, and, on the contrary, not conspicuous, or quite absent, in these parts when mature. Now, as to the downward pressing of the old outer leaves, I submit that this is merely the result of the "force," which keeps the leaves prostrate on the ground, acting without the resistance offered by that ground, owing to the severing of the root, which had served as an anchor or fulcrum. What the "force" is I do not venture to suggest, but I believe it is dependent on water tension and cell-growth. I am the more inclined to think this explanation of the deflection of the leaves may be the correct one by the fact that, so far as I can recall, and although I cannot remember the actual species, all those in which I have noticed this deflective tendency have been such as have their root leaves naturally arranged in a prostrate rosette at some period of their lives, and it is no question of the mere drooping of the leaves from lack of moisture or nourishment, but a rigid, downward pressure exerted until the plant will sometimes stand on the tips of its leaves like a three-legged stool on its legs.

Yours, etc.,
C. NICHOLSON.

Hale End, Chingford.

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

RADIAL MOTION IN SUNSPOTS.—At the last meeting of the Royal Astronomical Society, on March 12, a paper was read giving the details of some remarkable sunspot spectra photographed by Mr. J. Evershed at the Solar Physics Observatory, Kodaikanal, South India. On some of the plates the lines in the spot band were distinctly slanted with regard to the general direction of the spectrum lines, the slope being such that approximately equal and opposite shifts were seen at opposite ends of the spot line. This was obviously a phenomenon of very different nature to the mere Doppler effect of radial motion in the line of sight, and, in consequence of the various changes found to occur according to the relative direction of the slit with respect to the centre of the sun's disc, and also to the position of the spot on the disc, Mr. Evershed explains the appearances as being due to the radial streaming of the spot vapours out from the central core in all directions. If the spot is exactly in the centre of the disc, all these motions will be tangential to the sun's surface; they will, therefore, have no component velocity in the line of the observer, and the lines will not be distorted. This, theoretically, should only be so for the centre, but owing to the delicacy of the observation, it was found impracticable to detect any slant of the lines unless the spot was more than 10° from the centre of the disc. It was then found if the slit was directed through the spot along a solar radius, pointing to the centre of the disc, that the distortion was a maximum, while if it was turned through 90° from this position the distortion vanished. These facts will doubtless furnish another powerful method of examining the complicated mechanism of the disturbed solar regions near spots.

FORMATION AND GROWTH OF SUNSPOTS.—By means of a beautiful series of spectroheliograms taken with the Rumford spectroheliograph of the Yerkes Observatory, Messrs. P. Fox and G. Abetti show very clearly the cycle of phenomena which accompany the formation and growth of a typical sunspot. It has often been noticed that spots tend to originate in pairs, north and south of the solar equator, and the accompanying photograph illustrates the gradual growth of the companion spot to a southern one already in existence. The dates of each section are given, from which it appears that the first indication of the disturbance showed as a small, bright flocculus on May 6. This gradually increased in extent, and on May 7 there is a distinct record of the small, dark umbra on the western border of the flocculus, which by May 9 shows as a well developed spot. On the last plate, May 13, the spot is shown much broken up just before it reaches the limb of the sun. As usual, it is seen that the spot is at the *preceding* border of the flocculus.

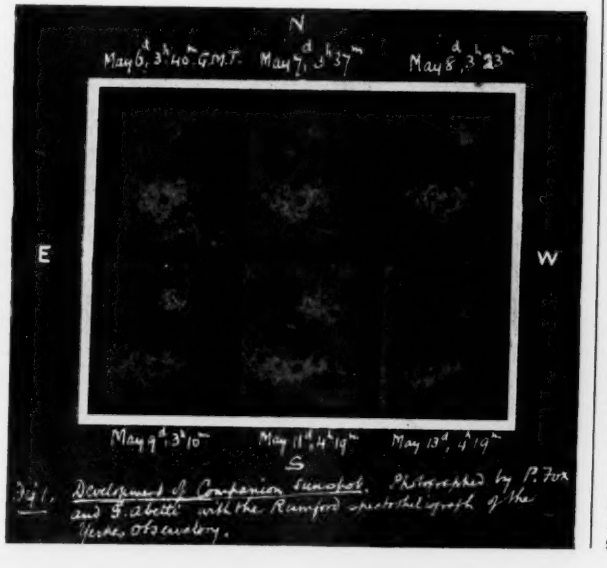


Fig. 1. Development of Companion sunspot. Photographed by P. Fox and G. Abetti with the Rumford spectrohelioscope of the Yerkes Observatory.

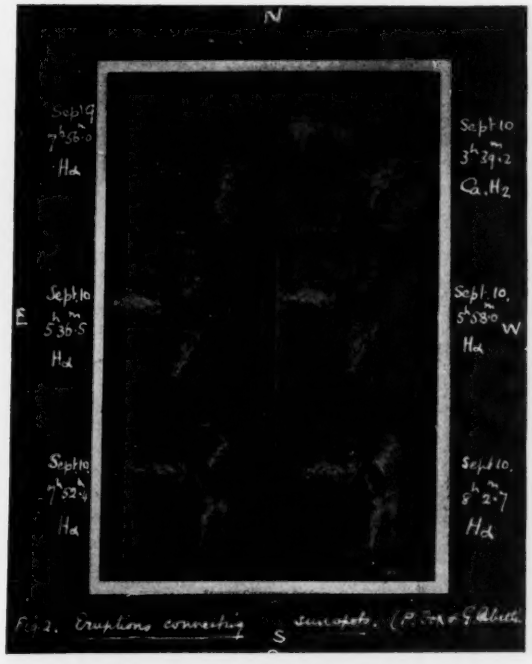
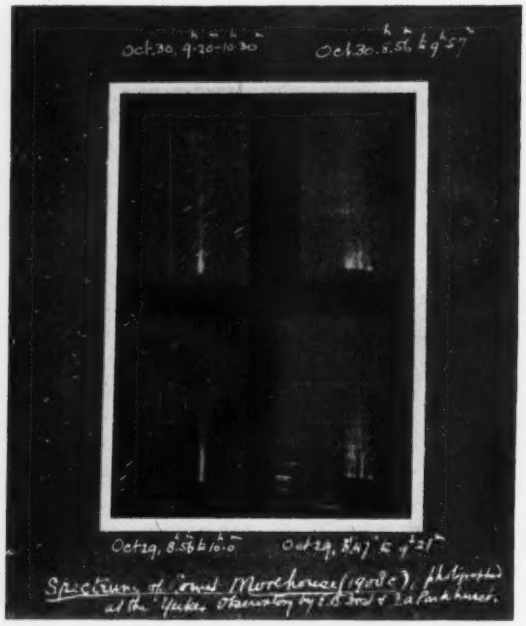


Fig. 2. Eruptions connecting sunspots. (P. Fox & G. Abetti.)

The second figure shows the intimacy of action between two spots near the solar equator, one north and the other south. On September 9 and 10d. 3h. the areas of disturbance are distinct, but a few hours later various patches of flocculi appear between the spots, and by 8h. 2.7m. on the 10th there is a definite bridge of flocculus material stretching out from the northern border of the southern spot, towards the other nucleus. We see here evidence of a tremendous eruption having occurred behind and in contact with the southern spot. Further away still there is another eruption somewhat resembling a great leg, stretching towards the north in two branches, one nearly to the neighbouring spot, the other as a chain of brilliant eruptions reaching towards the isolated flocculus. As illustration of the enormous energy involved in these solar disturbances it is stated that during the ensuing subsidence of the material velocities of 100 km. and 170 km. per second were observed, and that in about four hours the whole display was over.

SPECTRUM OF COMET MOREHOUSE (1908 c).—Messrs. E. B. Frost and J. A. Parkhurst were very successful in obtaining excellent photographs of the spectrum of this most interesting comet, and their discussion of the results brings out several points of difference from the conclusions drawn by other observers. The spectra were first obtained with a Zeiss doublet lens of 14.5 cm. aperture and 81.4 cm. focal length, having an objective prism of 15° angle. The dispersion was such that the distance from $H\beta$ (λ4861) to $H\theta$ (λ3798) in a stellar spectrum was 3.0 mm. Twenty-one satisfactory plates were obtained between October 28 and December 2. In the absence of any reference lines on the spectra, reductions were effected by the help of comparison

spectra of the comet taken with a slit spectroscope, and also by stellar spectra placed as nearly as possible alongside the comet. The general appearance of the spectra will be clear from the accompanying reproduction, in which the left-hand pictures show the comet as photographed with an ordinary camera, and the right-hand pictures the spectra taken with the objective prism. Careful search was made on all the plates for evidence of continuous spectrum, but it was not detected. The spectral images do not give the impression of being bands, but simply monochromatic images of the head of the comet. A feature of special interest is the way in which the relation of the constitution of the head and streamers is shown; for this the spectra pictures must be carefully compared with the left-hand pictures taken with integrated light. The streamer proceeding from the head knot at λ4711, though certainly present, is very weak compared with the streamers from the fainter


Oct. 30, 9.20–10.30
Oct. 30. 8.56, 9.57
Oct. 29, 8.56–10.0
Oct. 29, 8.47 & 9.21
Spectrum of Comet Morehouse (1908c), photographed at the Yerkes Observatory by E. E. Barnard & J. A. Parkhurst.

knots λ4017 and λ4561. A close examination also shows that the strongest knot of all, λ3883, is also deficient in tail material. It is noticeable that these two knots, deficient in tail material, extend perceptibly farther towards the sun than the other knots. Great importance attaches to the fact that on one of the photographs two of the streamers, which are thrown out from the head in directions at least 40° apart, show the same spectral composition. Incidentally it may be mentioned that these straight tails should, by the commonly accepted theory, be composed of hydrogen, whereas these photographs show they are made up of carbon and cyanogen. In spite of the extraordinary activity of this comet, all the different plates which are similar in quality show practically identical spectra, so that the constitution of the various parts of the comet appears to have remained unchanged throughout the period covered by these observations.—(*Astrophysical Journal*, Vol. 29, pp. 55-64, January, 1909.)

BOTANY.

By G. MASSEE.

THE NEW FLORA OF KRAKATAU.—It will be remembered that in 1883 the whole of the vegetation of the island of Krakatau, situated in the middle of the Sunda Strait, between Java and Sumatra, was completely destroyed by the most violent volcanic outburst of historic times. An account of the gradual building up of a new Flora has been given by Dr. Ernst in a German periodical. This has been translated by Professor Seward, and is issued in book form by the Cambridge University Press. In the case of coral islands the first land plants are brought by ocean currents, which carry seeds and fruits of strand-plants, some of which are capable of floating for weeks, or even months, in the sea without losing the power of germination. Birds are the second most important factor in conveying seeds and fruit; wind and other agents also assist. The actual method of re-stocking Krakatau with a new vegetation has, however, been shown to have proceeded on totally different lines. In 1886, three years after the eruption, the pioneers of a new vegetation were present from the shore to the peak. Blue-green algæ were the first to secure a footing on the pumice and volcanic ash. Diatoms and bacteria were also present. These formed a suitable nidus for the germination of the spores of mosses, ferns, and the seeds of various kinds of flowering plants adapted for dispersal by air currents. A characteristic feature at this stage was the preponderance of ferns belonging to eleven species widely distributed in the Indo-Malay Archipelago. From the above account it will be seen that wind was the agent in enabling the earliest forms of plant life to establish themselves on the island. At the same time nine species of flowering plants were met with on the beach, the seeds of which had germinated on being washed up by the sea. Plants introduced by man or animals were absent at the date mentioned above.

In 1906, when the island was again visited, the progress made by the vegetation was remarkable; the whole of the south side from the beach to the summit was covered with green. The forest near the beach consisted of typical strand-plants, Casnarinas from 39-49 feet high formed the largest proportion. Climbing plants were also abundant, as *Cassytha*, *Vigna*, *Vitis trifolia* etc. A fine specimen of *Cycas circinalis* having a trunk five feet nine inches high was also observed. Cocoanut palms towered above the other trees, and were found on close acquaintance to be laden with fruit. Some of the nuts had fallen to the ground, germinated, and produced seedlings a yard high, proving that the trees had reached the fruiting stage some years previous. Further inland *Barringtonia speciosa*, the most beautiful tree of the tropical strand-forest, was in bloom. Six species of fig trees were present; these and *Trichosanthes* belong to those colonists the seeds of which are distributed by fruit-eating birds. Screw-pines bearing large, ripe clusters of fruit were also in evidence. Grasses and sedges were also present in abundance.

The present number of plants collected in Krakatau and adjoining islands that were equally deprived of vegetation is 137, and includes representatives of all divisions of the plant kingdom. A yellow-brown lizard nearly a yard long was seen.

THE PHYTOPLANKTON OF THE ENGLISH LAKE DISTRICT.—An admirable account of the phytoplankton of the English Lake District is given by the well-known algologists, W. West and G. S. West, in the *Naturalist* for March. The collections of plankton have extended over several years, and the complete knowledge previously possessed by the authors of the general Alga-flora of the Lake District enabled them to thoroughly appreciate the differences between the phytoplankton and the general Alga-flora, and to indicate the existing relationships between the two. The district possesses a richer Alga-flora than any other part of England. The phytoplankton of the lakes is similarly rich in species. Eighteen lakes were examined for their phytoplankton. Regular collections from Windermere, Wastwater, and Ennerdalewater were examined monthly, in order to obtain an adequate idea of the periodicity of the various constituents of the phytoplankton. The bulk of plankton increases in proportion to contamination of the water from hamlets, farmhouses, etc. Ullswater, one of the larger lakes, illustrates this point. Wastwater furnished quantities of *Elakatothrix gelatinosa*, Wille, a species not previously observed in any other British lake. In addition to the characteristic plant species, crustacea, Rotifers, Entomostraca, etc., are noted. Three excellent plates illustrate the plankton of different lakes.

ON THE NECESSITY FOR MORE PRECISION IN THE DETERMINATION OF SPECIFIC CHARACTERS IN MOULDS.—Dr. Mangin points out in *Bull. Soc. Bot. France* the necessity for greater exactness in the determination of the

lower or conidial forms of fungi. He is convinced from a series of experiments that the usually accepted characters, form, and dimensions of the conidiophores or spore-bearing branches, size and nature of the markings or ornamentation of the spore-wall, etc., are by no means constant, but are to a great extent variable, depending on conditions. Variations of temperature are capable of causing very marked differences in the nature of the markings or ornamentation of the spore-wall, a point considered at present of importance in the discrimination of species. On the other hand, equally marked variation in the size, mode of growth, and branching of the conidiophores is the result of different nutritive substances, the temperature remaining constant. In the Aspergillace, with which the author experimented, it was found that temperature modified the form and size of the spores according to a constant law. At the optimum temperature, and growing in the most favourable nutritive medium, the conidia were of constant form and size. When above or below the optimum temperature, the conidia increase in size, at the same time they vary much in size, and these points become augmented as the temperature limits of growth are approached. As a rule the ornamentation of the spore-wall becomes modified, and gradually disappears as the temperature increases.

It is considered that if temperature was taken into consideration in those cases where the plants are amenable to cultivation under artificial conditions the range of forms produced between maximum and minimum, optimum being taken to represent typical form, would indicate the various stages a species can assume under different conditions of temperature. This would enable us to eliminate from specific rank numerous so-called species that are, in reality, only modified conditions of other species.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

RECOGNITION OF STEEL BY ITS SPARKS.—It has been observed by Herr Bermann that the form and appearance of the sparks emitted on grinding steel upon an emery wheel vary with the composition of the steel. Thus, by taking precautions to produce the sparks under parallel conditions, it is frequently possible to determine the kind of steel whence they were emitted. The nature of the grinding wheel and the speed at which it is driven have some influence upon the colour and brilliancy of the sparks, but not upon the form of what may be termed the spark image. In the case of soft steel the distinctive form of the spark image is that of a sheaf of a few needle-like lines, issuing almost in an explosive fashion from a glowing nucleus. The number of these pointed lines depends upon the proportion of carbon in the steel, and thus affords a rough measure of that constituent. A very different spark image is obtained with manganese steel, the ends of the separate spark-rays being characterised by leaf-like expansions. The sparks from tungsten steel, again, appear as dark red lines, and if the steel be pressed strongly against the wheel the extremities of the rays appear as drops, from which issue branch rays terminating in little knobs like the head of a pin. Chrome tungsten steel may be distinguished from tungsten steel by emitting two kinds of spark rays, one consisting of thin dark red lines and the other of thicker purple-red lines quite distinct from any given off by tungsten steel. The sparks from nickel steel have the same appearance as those from carbon steel, while those emitted by cast-iron vary in form and colour with the composition of the iron.

THE FORMATION OF CRACKS IN OIL PAINTINGS.—A most instructive investigation has been made by Dr. Täuber to discover the causes of the cracking of the paint in pictures, and so far as possible to guard against them. The formation of cracks was found to vary very considerably with the nature of the surface pigment, and of the ground pigment, while the nature of the painted material (whether glass, iron, or sized paper) had no influence upon the results. Zinc white, white lead, and the two cobalt greens used as ground pigments form layers particularly liable to crack. Zinc white was also dangerous as a surface pigment. The greatest tendency to cracking was observed in the case of pigments laid over a grounding of red lead, though surface coats of red lead never cracked. The following pigments showed great tendency to form cracks:—Chrome yellow, the two cobalt blues, alizarine orange, carmine, light ochre, blue-green oxide, Naples yellow, and dark cadmium yellow. In practice the ground coating ought to be allowed to dry thoroughly before the next coating is applied in a thin layer. In further experiments to determine the influence of different oils it was found that poppy oil had the greatest effect in promoting the formation of cracks, then nut oil, and then linseed oil. Of 400 surfaces coated with poppy oil pigments 83 showed cracks after a few months, while 65 of the same number of surfaces coated with nut oil colours cracked, but only five in parallel experiments with linseed oil. It is suggested in explanation of the formation of cracks that certain pigments interact under suitable conditions and produce electrical currents which cause a state of tension in the still moist surface layer. A fact supporting this view is that cracks not infrequently occur while the upper coating is still soft and "tacky." Moreover, when coats of the same paint are spread in layers of the same thickness upon different non-absorbent surfaces the periods of drying are very different. For instance, a pigment consisting of zinc white in poppy oil yielded a dry film upon copper in nine days, on lead in 18 days, and on porcelain in six months, whereas a layer upon zinc took 12 months to dry. Taking porcelain to represent a neutral ground, it appears that copper and lead have an accelerating influence and zinc a retarding influence upon the drying of zinc white paint.

THE COMPOSITION OF SNOW IN LONDON.—Comparative analyses made in the laboratory of the "Lancet" of the snow that fell in London on Tuesday, December 29, of last year and on the first Sunday in March of this year show remarkable differences. In each case the samples were collected from the roof of the "Lancet" offices, and the great difference in the amounts of impurities collected by the snow on its way down is a striking demonstration of greater purity of the air in London on Sundays than on week days. The results expressed in grains per gallon of the melted snow were as follows:—

	Tuesday, 1908.	Sunday, 1909.
Suspended matter (chiefly soot, coal particles and tarry products)	30·32	6·65
Mineral matter in solution	4·20	1·93
Organic matter in solution	7·84	1·57
Free ammonia	0·07	0·05
Organic ammonia	0·01	0 02
Common salt	1·33	1·27
Sulphuric acid	3·36	trace

Even the state of relative purity of the snow that fell on the Sunday, however, shows to what an extent the air of London is ordinarily contaminated with the products of combustion of coal. From these analytical figures the "Lancet" estimates that the recent snowstorm brought down to the surface of the county of London no less than 75 tons of dissolved solids, 142 tons of suspended matters, 100 tons of coal, 25 tons of salt, and one ton of ammonia.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

IMPLEMENTS, PALÆOLITHIC AND EOLITHIC.—"Palæolithic Implements, etc., from Hackpen Hill, Winterbourne Bassett, and Knowle-Farm Pit (Wiltshire)" was the subject of a paper read before the Geological Society on February 24 by Rev. H. G. O. Kendall, M.A.

Implements were described from the localities mentioned in the title, which lie at heights of 885, 576, and 450 feet above O.D. respectively. Hackpen Hill forms a ridge of chalk running north and south, capped by patches of Tertiary clay. Trimmed stones of eolithic nature were obtained from fields ploughed in drift-gravels, together with abraded Upper Greensand chert, quartzite-pebbles, and small flints. The greater number of the flaked stones were

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found within and near shallow pits excavated in yellow drift-clay, apparently newer than the red clay with flints, exposed at the edges of the larger hollows. The implements are unabraded, abraded, and striated; some stained brown, some green, others unstained; evidently some are *in situ*, others were brought with the drift. Implements taken from the clay are described, and a distinction is made between the palæoliths and neoliths obtained from the same surface. The similarity in the mineral condition of the former to palæoliths from Knowle-Farm Pit was pointed out, and both were referred to the Chelléen period. It is noteworthy that, while implements and flakes are numerous on the top of Hackpen Hill as compared with good, trimmed pieces, yet at this 570-foot level on the Winterbourne-Bassett plain implements and flakes are very scarce, while trimmed pieces are very numerous, although the level of the Winterbourne stones is 300 feet lower. Many of the latter, however, have been evidently rechipped, and are, therefore, of later date. Mr. Kendall concludes that implements of at least three palæolithic periods are found at Knowle, and these three periods may be compared with the Chelléen, Lower Acheulien, and Upper Acheulien of Professor Commont at St. Acheul. Still older implements (possibly earlier Chelléen) seem also to occur. In the discussion on the paper, Mr. W. Johnson expressed his regret that the term "eolithic" had been used as a type, rather than as a definite archæological period. It was true, he said, that very rude implements, suggestive of eoliths, were found on the North Downs, but, apart from their being surface-relics, it was doubtful whether, like eoliths, they could be assigned to a few definite groups. The occurrence, at low levels, of implements rougher than those of the older terraces was no new problem. The Solutréen implements of the Cave Period were often of finer workmanship than those of the succeeding Magdalénien epoch. But, in paying close attention to stratigraphy and to types, workers would, by careful classification, greatly assist the geologist. Recently, Mr. William Wright had discovered palæoliths in excavations at Clapham Common. The gravels of Wimbledon Common, however, different in level and in composition, had as yet furnished no such records. It was in such cases that discoveries and grouping by types might help in determining the relative ages of the beds.

CRETACEOUS PLANT-NODULES FROM JAPAN.—Miss Marie C. Stopes, D.Sc., Ph.D., has been doing good geological work in Japan, and has recently presented an interesting paper on "Plant-containing Nodules from Japan, Considered Structurally in their Relation to the 'Coal-Balls' and 'Roof-Nodules' of the European Carboniferous." These nodules are of interest, she points out, because of the plant and animal fossils that they contain. The plant-petrifactions are of a type unknown from the Mesozoic, and will be described separately. The nodules are of Cretaceous age. They enclose numerous marine shells and various plant-remains, well petrified. Unlike the "coal-balls" and "roof-nodules," they are not contained in coal-seams or in the roof thereof, but occur in a thick series of shales below the coals, which appear to be of Tertiary age. The microscopic aspect of the matrix shows that it is highly granular, unlike the matrix of coal-balls and roof-nodules. Chemically they consist of about 60 per cent. of carbonates, both lime and magnesia being present, with 30 per cent. of silicates; the large proportion of silicates is an important point of difference from the Carboniferous nodules. In having numerous plant-fragments in a single nodule and in the type of petrifaction the nodules are like coal-balls; in having marine shells included in the matrix they are more like roof-nodules. They probably represent fragments of tangled *débris*, which drifted out to sea but a short distance, and then were speedily petrified.

NEW RED PETROGRAPHY.—Mr. Herbert Henry Thomas, M.A., B.Sc., F.G.S., read a paper on the "Petrography of the New Red Sandstone in the West of England" before the Geological Society of London on March 10. The results obtained are based on the microscopic investigation of a large number of samples taken from various New Red horizons and localities in Devon and Somerset. In the description of certain mineral species it is suggested that anatase occurs both as detrital crystals and as crystalline groups formed in the rocks since their deposition. The forms presented by grains of staurolite as well as certain crystals of tourmaline with an unusual habit are described. It is recognised that the various divisions of the New Red Sandstone, namely, the Lower Breccias and Sandstones, the Lower Marls, the Pebble-Bed, and the Upper Marls and Sandstones, although linked together by a general similarity of mineralogical composition, present physical and mineralogical differences indicative of variations in the source of supply and conditions of deposition. The rounding of the grains is most complete (millet-seed) in the sandstones of the Lower Breccias and Sandstones, a feature continued, but in a less striking manner, into the overlying division. With regard to the vertical and horizontal distribution of minerals, it is found that staurolite is abundant in the Lower Breccias and Sandstones of the extreme south of Devon, but less plentiful northwards; that garnet is present in all the New Red rocks of North Devon and Somerset, but in Southern and Central Devon only occurs in the Lower Marls and in the Upper Marls and Sandstones.

IMPLEMENTS FROM THE VICTORIA FALLS.—Mr. Thomas Codrington, F.G.S., in his fiftieth year as a Fellow of the Geological Society, has celebrated the occasion by reading a paper on "Some Notes on the Neighbourhood of Victoria Falls." The basalt lies in the valley of the Zambesi below and above the Victoria Falls, and this has determined the features of the river. The basalt through which the Batoka Gorge has been cut appears in the course of the Zambesi for two miles above the Victoria Falls, causing rapids over rocky bars between many islands. It then disappears, and the river above flows quietly between alluvial flats for five miles, the basalt being traceable here and there below the water until above Candabar Island it again rises and constitutes the bed of the river from bank to bank, causing rapids that extend for many miles up the river. Attention is called to a wide tributary valley which joins the main Zambesi Valley on the east at the Falls; and to the Maramba River flowing down it, and its fluviatile deposits. The discovery of stone-implements and artificially-worked stones in the gravel and the bed of the Maramba is interesting. The very large majority of flakes and flaked stones having no trace of design over those that can be considered as implements, however rough, suggests that the manufacture of stone tools on a large scale was here carried on for use in the sand-covered country on both sides of the Zambesi, where there is no stone; and the difference in the proportion of sharp unworn specimens to those apparently waterworn seems to show that while many were made on the ground, the flakes and refuse of the making of many more were brought down from the tributary valley on the east. There is apparently no evidence as to the age of the implements found near the Zambesi; none have been found in gravel that belongs to that river, and the presumption appears strong that they were made from quartzite found on the surface since the Batoka Gorge was eroded. It is stated that the natives do not now make use of any of the types of Pleistocene implements which have been found.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE DRY FEBRUARY.—Owing to the anticyclonic conditions which prevailed during the month of February, the weather was fine and dry, with a large amount of sunshine and slight rainfall in all parts of the country. Dr. H. R. Mill reports that less than half the average rainfall occurred in the east of Scotland, between the Moray Firth and the Firth of Forth, in the south-east of Ireland, and over practically the whole of England and Wales, south of the Mersey and Humber. The driest parts of the country relatively to the average were the counties of Devon, Somerset, Dorset, Wiltshire, Hampshire, Berkshire, Buckinghamshire, Oxfordshire, and most of Bedfordshire and Cambridgeshire, in all of which less than one-quarter of the normal supply of rainfall was received. A considerable area near Cambridge had less than a quarter of an inch.

THE RECENT COLD WEATHER.—Cold weather prevailed over the whole of England and Wales after the first week of February till about the middle of March. The air was keen, with the wind mostly from the north-east. During the first few days of March very low minimum temperatures were recorded, the thermometer falling to zero at Marlborough on the 3rd. The widespread character of the cold weather will be clearly seen from the figures for each week in the following table, which has been compiled from the "Weekly Weather Report" of the Meteorological Office.

Week ending	Feb. 13.		Feb. 20.		Feb. 27.		March 6.		March 13.	
Districts.	Temperature.	Diff. from Average.	Temperature.	Diff. from Average.	Temperature.	Diff. from Average.	Temperature.	Diff. from Average.	Temperature.	Diff. from Average.
	°	°	°	°	°	°	°	°	°	°
England, N.E.	34·7	−4·0	37·2	−1·2	36·5	−2·0	31·6	−7·1	35·9	−3·6
,, E.	34·9	−3·5	36·8	−1·4	34·2	−4·2	30·8	−8·0	36·5	−3·1
,, Midlands	34·5	−4·1	36·4	−2·0	34·2	−4·3	29·1	−9·7	35·3	−4·4
,, S.E.	35·6	−4·4	37·1	−2·6	34·4	−5·4	29·7	−10·3	37·2	−3·6
,, N.W.	36·3	−3·3	38·4	−0·9	37·6	−1·8	31·1	−8·4	36·5	−3·6
,, S.W.	37·7	−3·5	40·0	−1·0	36·9	−4·1	31·3	−9·7	37·0	−4·5
Eng. Channel	41·6	−2·4	42·6	−1·3	41·6	−2·4	36·9	−6·9	41·4	−2·8

WIND-WAVES IN WATER, SAND, AND SNOW.—Dr. Vaughan Cornish gave an interesting lecture on "Wind-Waves in Water, Sand, and Snow" at the meeting of the Royal Meteorological Society on March 17, which he illustrated by numerous photographs taken during his travels.

Dealing first with waves of the sea, he described the gradual evolution of large sea waves during the passage of a cyclone or other depression across the Atlantic. The great sea-waves are produced at that portion of the cyclone where the direction of the wind coincides with the direction of advance of the depression. Along this line of advance the waves in their gravitational progress are accompanied by a strong wind blowing across their ridges as long as the atmospheric depression maintains itself. Thus the waves are developed until they attain a considerable steepness. The average height attained by these waves (in feet) is about half the velocity of the wind (in miles per hour). Thus a wind of 52 miles per hour gives waves of an average height of about 26 feet, although individuals will then attain a height of 40 feet. In the circumpolar southern ocean the height of North Atlantic waves is somewhat exceeded, but the outstanding feature of the waves of high southern latitudes is their greater length from crest to crest. South of the Cape of Good Hope and of Cape Horn there is neither windward nor leeward shore and the prevailing wind in all longitudes is westerly. Thus, wherever a westerly wind springs up it finds a long westerly swell, the effect of a previous wind, still running, and the principal effect of the newly-born wind is to increase the steepness of the already-running long swell so as to form majestic storm waves, which sometimes attain a length of 1,200 feet from crest to crest. The longest swells due to wind are almost invisible during storms, for they are masked by the shorter and steeper waves. They emerge into view, however, after or beyond the storm, and Dr. Cornish has found their speed to be approximately equal to that of the wind by which they are created, sometimes attaining even in the North Atlantic a velocity of more than sixty miles per hour.

The action of the wind to drift dry sand in a procession of regular waves was studied by the lecturer in the Egyptian deserts. As the sand-waves are unable to travel by gravitation, as do the waves of the sea, their movements are entirely directed and controlled by the wind, and are, therefore, much simpler and more regular in form and movement than ocean waves. When they grow to great size, as in the desert sand-dunes, which attain a height of several hundred feet, the forms become more complicated, owing to the partial consolidation of the lower layers of sand by pressure. Nevertheless, the characteristic wave-form can still be distinguished.

For the purpose of studying snow-waves Dr. Cornish traversed Canada twice during winter, and found the phenomenon best developed on the prairies near Winnipeg, when the temperature was below zero and the snow had quite lost the adhesive character which it retains in warmer weather. Freshly-fallen dry snow is drifted by wind in a procession of regular waves, progressing with a visible and ghost-like motion. They are similar to desert sand-waves, but less than half as steep, the wave-length being fifty times as great as the height. The flatness of the wind-formed snow-waves affords a valuable indication of the great distance to which hills give effective shelter from wind, and helps to explain the climatic advantages of certain localities. The forms of snow-drifts produced in the neighbourhood of obstructions were also studied by the lecturer. Multitudinous shapes are assumed while the eddy-space formed by the obstacle is being filled up with snow, but when sufficient snow has fallen and been drifted in so that the space is filled the vertical section drift is Icthyomorphic (fish-shaped) with a blunt head and tapering tail, which is the form of least eddy-making resistance.

DEW-PONDS.—At a recent meeting of the Royal Society of Arts, Mr. G. Hubbard read an interesting paper on Dew-Ponds. The essential difference between a dew-pond and an ordinary pond lies in the fact that the ordinary pond obtains its water supply from springs or surface water drainage, but the dew-pond, owing to its special form of construction and the nature of the materials used in it, will condense the moisture from the air. The author gives the following particulars as to its construction:—"Operations are commenced by hollowing out the earth for a space far in excess of the apparent requirements of the proposed pond. The whole of the hollow is then thickly covered with a coating of dry straw. The straw in its turn is covered by a layer of well-chosen, finely-puddled clay, and the upper surface of the clay is then closely strewn with stones. Care must be taken that the margin of the straw is effectively protected by clay." The pond will gradually become filled with water, the more rapidly the larger it is, even though no rain may fall. If such a structure is situated on the summit of a down, during the warmth of a summer day the earth will have stored a considerable amount of heat, while the pond, protected from the heat by the non-conductivity of the straw, is at the same time chilled by the process of evaporation from the puddled clay. The consequence is that during the night the moisture of the comparatively warm air is condensed on the surface of the cold clay. Owing to the chilling effect of evaporation from this thermally isolated surface, the condensation during the night is in excess of the evaporation during the day, and the pond becomes, night by night, gradually filled.

THE ELECTRICITY OF RAIN.—Dr. G. C. Simpson, in a recent paper read before the Royal Society on "The Electricity of Rain and its Origin in Thunderstorms," stated that during 1907-8 an investigation was undertaken at the Indian Meteorological Office at Simla into the electrical phenomena which accompany rain and thunderstorms. From the results obtained, Dr. Simpson now puts forward the following theory:—

"It is exceedingly probable that in all thunderstorms ascending currents greater than eight metres a second occur. Such currents are the source of large amounts of water which cannot fall through the ascending air. Hence, at the top of the current, where the vertical velocity is reduced on account of the lateral motion of the air, there will be an accumulation of water. This water will be in the form of drops which are continually going through the process of growing from small drops into drops large enough to be broken. Every time a drop breaks, a separation of electricity takes place, the water receives a positive charge and the air a corresponding amount of negative ions. The air carries away the negative ions, but leaves the positively charged water behind. A given mass of water may be broken up many times before it falls, and, in consequence, may obtain a high positive charge. When this water finally reaches the ground it is recognised as positively charged rain. The ions which travel along with the air are rapidly absorbed by the cloud particles, and in time the cloud itself may become highly charged with negative electricity. Now, within a highly electrified cloud there must be rapid combination of the water drops, and from it considerable rain will fall; this rain will be negatively charged.

"A rough quantitative analysis shows that the order of

magnitude of the electrical separation which accompanies the breaking of a drop is sufficient to account for the electrical effects observed in the most violent thunderstorms. All the results of the observations of the electricity of rain described in the paper are capable of explanation by the theory, which also agrees well with the actual meteorological phenomena observed during thunderstorms."

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

MIGRATORY BIRDS AND THEIR NESTING AREAS.—An unusually interesting paper on the subject of the nesting areas of some of our summer migrants appears in the March number of *British Birds*, which we commend to the notice of the readers of "KNOWLEDGE," more especially as it will serve as a guide to further immediate observation on this head.

The authors, Messrs. C. J. and H. G. Alexander, convinced that "in many species each pair inhabits a definite area, into which other pairs do not intrude," commenced in 1907 to mark the positions taken up by such birds on 6-inch Ordnance Survey Maps: a considerable area round Tunbridge Wells and at Wye, near Ashford, forming the scenes of their labours.

It would be impossible to do justice to the author's work in a brief abstract. It must suffice, then, to say that some seventeen species are included in this work.

They find that the females seem always a few days behind the males, and, what is no less interesting, those males which arrive first are first joined by females, which suggests "that the same female returns to the haunt of its mate year after year."

The young seem to disappear earlier than their parents in most species.

In placing a pair of birds on the map the authors generally relied on the singing of the male, though in many cases they saw the female as well, and occasionally found the nest.

To make their methods of work the more clear the authors have included a map in their paper, giving the nesting area of twelve species in a part of the Borough of Tunbridge Wells.

This work, it is interesting to remark, confirms, in a most complete manner, the observations of Mr. E. Eliott Howard in his wonderful monograph of the British Warblers which is now passing through the press.

RINGING BIRDS.—Experiments are now being made, on an extensive scale, in the Ornithological Stations of Hungary and Rossiten, in ringing birds with a view to discovering their range in space. In this country, so far, but little has been done. We suggest that such of our readers as have the time and opportunity should take advantage of the coming breeding season to attach suitable rings, clearly marked, to birds such as Starlings, Rooks, and Wood-pigeons, and, indeed, of as many species as can be managed. By the fortune of war more or fewer of these birds will be killed, and it will be interesting to note how far from their birthplace they have wandered and how long a time they kept their fate at bay.

GROUSE-DISEASE.—That dread enemy of the game preserves the "Grouse-disease" seems to evade all attempts at bringing it to bay. Some time since, it will be remembered, a "Grouse Disease" Commission was appointed to thoroughly investigate the causes of the periodic outbreaks of a disease which works havoc on the Grouse Moors, and the first fruits of this investigation are now in course of publication. This arduous task has mainly fallen on Mr. A. E. Shipley, of Cambridge, and Dr. E. A. Wilson, of Antarctic fame, than whom it would have been impossible to find more efficient investigators.

At the last meeting of the Zoological Society these gentlemen gave an account of that part of their work which deals with the external and internal parasites of these birds. These uninvited guests were very carefully studied in the hope that they might throw some light on the mystery of the disease. But although some new and interesting facts were brought to light, nothing that would connect those organisms with the epidemic known as Grouse-disease was discovered. Considerable mortality, however, seems to result from the accumulation of Strongylid worms—allies of the Gape-worm—in the Cæca. No cases of death from Klein's disease were met with.

BLACK-THROATED THRUSH IN KENT.—At the last meeting of the British Ornithologists' Club, Mr. T. Parkin exhibited a fine adult male Black-throated Thrush (*Turdus atrigularis*) which had been shot at Newenden, Kent, on January 29, making the third record of this Asiatic species for Great Britain.

HYBRID GROUSE AND BLACK GAME.—At this same meeting Mr. W. R. Ogilvie Grant exhibited a hybrid Grouse and Black-cock killed in Glen Trood, Kircudbrightshire, October 6, 1908. This bird, an immature male, agreed pretty closely with two similar males now in the British Museum. The most convincing evidence of the hybrid nature of this bird lay, perhaps, in the feathering of the bases of the toes, indicating the Grouse, and the naked, pectinated terminal portions which were undeniably derived from the Black-cock. Hybrids of this cross are rare; it is, therefore, a matter of satisfaction to know that this specimen has been presented to the British Museum of Natural History.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

THE DIFFUSION OF ACTINIUM AND THORIUM EMANATIONS.—Mr. Sidney Russ has recently made determinations of the comparative rates of diffusion into various gases, the object being to throw light on the discrepancy which at present exists between values given by various observers for the molecular weights of the emanations and the expected value which is not far from 222. The theory of the method employed has been given by Rutherford. A layer of radioactive material being placed at the bottom of a cylindrical vessel a gradient of the emanation is set up, the amount varying in geometric ratio with the height. The actual pressure of the emanation at any level is too small to be measured directly. The difficulty is overcome by placing a metal rod axially along the vessel and keeping the rod charged to a high negative potential. The active deposit—resulting from the decay of the emanation—settles upon the charged rod in amount proportional to the emanation which gives rise to it. Thus there is a layer of deposit formed on the rod which decreases in density from the bottom upwards according to the same law as that governing the distribution of the emanation which is produced by its diffusion. The rod can be placed so that different portions in succession are beneath the slit in a lead plate and the amount of alpha-radiation passing through the slit is measured by the ionisation it produces; this is proportional to the active deposit to which it is due. Plates may be substituted for the rod and treated in the same way.

The rate of diffusion depends not only upon the diffusing gas, but also upon the particular gas through which it diffuses. Thus, in air, hydrogen, carbon dioxide, and sulphur dioxide, the diffusion constant of actinium emanation was found to have the values .096, .330, .073, .062, which numbers are approximately proportional to the inverse square root of the density of the gas into which diffusion occurs. Into argon the value obtained is little different from that into air. In gases at different pressures the coefficient is practically inversely as the pressure, a similar result being found for thorium emanation.

Making use of the values found for the two emanations it is concluded that the molecular weight of thorium emanation is about 1.42 times that of actinium. This conclusion is quite in agreement with much of the recent work which has been done showing that actinium is not one of the products in the *direct* line of descent from uranium to radium. The general conclusion arrived at is that the emanations do not exhibit any anomalies in their laws of diffusion.—(*Phil. Mag.*, March, 1909.)

EFFECT OF RADIATIONS ON THE BRUSH DISCHARGE.—Messrs. Willows and Peck in 1905 found that radium emana-

tions have the power of extinguishing a brush discharge produced by a Wimshurst machine when the gap is greater than 3 or 4 inches. Mr. A. E. Garrett now shows that the same phenomenon can be produced by means of an induction coil capable of giving a 6-inch spark. This effect is attributed to the beta rays. Radium has practically no effect on the brush from a *pointed* anode. It is found that the sensitive nature of the brush depends upon the oscillatory character of the discharge, and it is thought probable that a side discharge takes place when the brush is extinguished by radium.—(*Physical Society*, March 12.)

ZOOLOGY.

By R. LYDEKKER.

MORE NEWSPAPER ZOOLOGY.—Another excellent example of newspaper zoology is to be found in the *Graphic* of March 3, where the author refers to Dr. Wieland's recent description of the great American Cretaceous turtle known as *Archelon ischyros*. In the first place the writer heads the paragraph a "Prehistoric Peep," a title which, though etymologically correct, is scientifically wrong. For in geology the term "Prehistoric" is definitely restricted to the period intervening between the Historic and the Tertiary Periods, and is, therefore, manifestly inapplicable to a reptile of cretaceous age. This, however, is a minor point. The statement to which I take exception is that "the most curious feature of this vast animal were the plates with which its chest and what we may call its abdomen were protected, and which is more properly called the plastron." Now, without taking any notice of the more than doubtful grammar, this sentence shows not only that the writer is totally ignorant of what he is writing about, but that he has never read Dr. Wieland's paper. In possessing four great plates in the plastron, *Archelon*, apart from details, does not differ from a modern turtle. The real interest of the creature lies in the fact that it shows a marked tendency to do away with the bony plates of the upper shell, or carapace, and to replace them with a superficial series of smaller bones comparable to the mosaic-like carapace of the leathery turtle, or luth.

In this respect the structure of *Archelon* and an allied contemporary genus has a most important bearing on the phylogeny of the turtles, and, indeed, of the chelonian order generally. For the leathery turtle has been referred by many naturalists to a group (the Atheca, or Athecata) totally distinct from the one including all other chelonians. But if, as the American cretaceous forms appear to indicate, the carapace of the leathery turtle is a secondary structure originally superimposed on the vanishing carapace of a turtle of a more or less ordinary type, the essential distinction between the Athecata and other turtles is brushed away at one stroke, and the leathery species is nothing more than a highly specialised offshoot from the typical stock. The point is not, indeed, at present fully proved, although the American specimens go a long way in indicating that such proof will ultimately be forthcoming.

A COINCIDENCE.—In a paper just about to be published by the Zoological Society I have given reasons for believing that the Sze-chuen representative of that remarkable ruminant the takin is specifically distinct from the typical *Budorcas taxicolor* of the Mishmi Hills, on the northern frontier of Assam. While this paper was in the press I received a copy of the issue of the *Records* of the Indian Museum for October last in which Mr. T. Bentham comes to very much the same conclusion, remarking that he is "perfectly willing to admit that the Mishmi and Tibetan animals are distinct, not so much on the evidence of coloration, but on that of the characteristics of the skull, on which the Tibetan animal, perhaps, deserves specific rank.

PAPERS READ.—At the meeting of the Zoological Society held on February 16, Dr. F. Wood-Jones presented a communication on the fauna of the Cocos-Kiing Atoll; Mr. Beddard discoursed on the anatomy of certain ungulate mammals, including tapirs, hyraxes, and the prongbuck; while a paper was presented from Dr. Trouessart on the white rhinoceros of the Sudan. At the meeting of March 2, Miss Poole contributed a paper on the development of the chambers in the pleuro-peritoneal cavity of birds; Mr. E. S. Russell on the same occasion described the rate of growth of the limpet; while Mr. F. Balfour-Browne discussed the life-history of a dragon-fly, and Mr. D. Lang communicated observations on the growth-stages in a British coral.

REVIEWS OF BOOKS.

ANTHROPOLOGY.

Guide to the Specimens Illustrating the Races of Mankind (London: 1908; 31 pp., 16 figures; 4d.).—The Trustees of the British Museum were well advised to publish a guide-book to the admirable anthropological exhibition arranged by Mr. Lydekker in the Natural History Museum, as that collection is not sufficiently well known, although it is the only one of its kind in the country. Mr. Lydekker was naturally entrusted with the production of the guide, and although it serves the purpose of explaining the exhibits, it is a pity the author did not take the opportunity of giving a more scientific classification of mankind, for which his training in systematic zoology should have rendered him capable. He has simply put together various peoples and groups under the three headings of Caucasian, or White Races; Mongolian, or Yellow and Red Races; and Negro, or Black Races. Is it not time that the term Caucasian was dropped? Everyone knows who has studied the subject how particularly difficult it is to make a classification of mankind, and even a tentative attempt would have been better than none at all. Exception can also be taken to many statements, such as, for instance, that the skull of the Negritos is "remarkable for its shortness and breadth"—it is short because it is small—but it is by no means a broad skull as brachycephaly goes. Hottentots are not "black." The Alpine race, which extends along the mountain zone from Brittany to the Pamirs, is not even mentioned. Among the "slips" we may mention Malch for Maloh (p. 21). On the whole, the descriptions of the groups are well done, and will prove useful. The illustrations are very good and add greatly to the value of the little book.

The Fijians: a Study of the Decay of Custom, by Basil Thomson (London: Heinemann, 1908; pp. x. and 396; 10s. net).—A long residence in Fiji, where he occupied several important official posts, including that of Active Head of the Native Department, has rendered the author of this volume peculiarly fitted for his self-imposed task; and it is well from all points of view that he saw his way to undertake the task, for, as indicated in the title, the ancient customs of the Fijians are being rapidly replaced by a kind of bastard civilisation, and the record here laid before the world is therefore of priceless value. The Fijians are a nationality of special interest on account of forming the extreme eastern out-post of the Melanesian stock. That they came from the west, and that at no very distant date, the author is fully convinced, while he is equally confident that the theory of their having been preceded by a Polynesian colonisation is untenable. The work does not take into account the physical characteristics of the Fijians, as this has already been treated in full detail by other writers; but we have an admirable survey of all that is known with regard to their history and early intercourse with Europeans, together with full descriptions of their chief customs. As regards their present condition, the account given is not very inspiriting. The *pax britannica*, by putting a stop to intertribal wars, has removed the one stimulus to stamina and strength of character; and the natives have now drifted into an idle, listless condition with scarce sufficient energy to till the ground. Still, there is no reason to despair, in the author's opinion, of the ultimate arrival of the Fijians at some degree of physical and moral prosperity, when the present transitional state of affairs has passed away. For the thorough and interesting manner in which he has carried out his task, the author is entitled to the best thanks of all ethnologists.

ARCHÆOLOGY.

The Book of the Kings of Egypt, etc., by E. A. Wallis Budge, M.A., Vol. I. Dynasties I.-XIX.; Vol. II.

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Dynasties XX.-XXX. (London: Kegan Paul and Co., 1908; 12s. net).—In Volumes XXIII. and XXIV. of the comprehensive and deeply interesting series of "Books on Egypt and Chaldæa," Dr. Wallis Budge has collected together the Ka, Nebti, Horus, Suten Bât, and Rà names of the Pharaohs and Egyptian royal personages that have been discovered on the monuments. Such a work is, of course, invaluable to students of Egyptology, for not only has the work of excavations greatly added to the number of royal names formerly known, but both the two earlier works of importance on this subject, the "Königsbuch" of Lepsius and the "Le Livre des Rois" of Burgsch and Bouriant have long been out of print. The material here published has been elucidated by Dr. Budge in an introductory chapter of extraordinary interest, and some of the most difficult points, especially those connected with Egyptian chronology, briefly indicated. Lepsius' invaluable "Königsbuch der Alten Ägypter," which appeared in the middle of the last century, marked the first scholarly attempt to reduce to order the confused chronological statements in Egyptian texts; and though some of his conclusions have been inevitably proved erroneous in the light of subsequent discoveries, many have been verified by them. He it was, who first pointed out that the greater number of the Pharaohs, the Ptolemies, and Roman Emperors after them possessed five names. The import and nature of these names Dr. Budge goes on to describe. The subject, fascinating as it is, cannot be dealt with here at length; we can only briefly indicate its nature by explaining that the first or "Horus Name" was that borne by the King, as the representative of Horus, the Great God of Heaven, who was symbolised by a Hawk. This name was given to his Ka or "double," the shadowy or ghostly form of the man, a custom which dates from the first dynasty. It is written by a symbol which some Egyptologists believe to indicate a tomb or temple "wherein the Double of the King received both during his lifetime and after his death the divine cult and the funerary cult." The minute and delicate symbols which form so large a part of the text have been beautifully printed by Herr Adolf Holzhausen.

ASTRONOMY.

Astronomy of To-day, by Cecil J. Dolmage (London: Seeley and Co., 1909; 363 pp., with coloured frontispiece, 24 plates, and 20 diagrams; 5s.).—This book is invested with a melancholy interest by the death of the author not many weeks after publication, his health having for months been so bad that the completion of his work was doubtful. Finished it was, however, and bears no obvious trace of any want of care such as might very well have been expected under the circumstances. We may congratulate Mr. Dolmage's relatives and friends upon an admirable piece of work. The object of the book is "to give an account of the science of astronomy as it is known at the present day in a manner acceptable to the general reader," and this programme Mr. Dolmage has succeeded in carrying out with considerable success. The various portions of the subject are, on the whole, well balanced, and though it may seem that undue prominence is given to such a detail as the apparent magnification of the moon on the horizon, as compared with the almost perfunctory account of the tides, yet it must be remembered that the former is responsible for a great deal of writing in support of different explanations, and is, moreover, a pet theme of the author's, while the latter is a more strictly mathematical matter, perhaps of less popular interest. The "tide on the other side" admits of an explanation at least as simple and certainly more satisfying than the short paragraph devoted to its fellow. There are bound to be a few inaccuracies in a book of this kind. For instance, Phœbe is not the only instance of "retrograde" motion in the solar system, as (in addition to the eighth satellite of Jupiter, whose discovery was known to the author, but not until after the statement about Phœbe was written, and whose motion in any case was not at first determined) the satellites of Uranus are generally considered to be "retrograde," and that of Neptune is certainly so. Though the title of the book is "Astronomy of To-day," we find several sections in which the historical element is prominent, such as the chapters on Famous Eclipses and Remarkable Comets, but it cannot be said that the presence of these is a drawback or even an inconsistency in a work of this kind. The arrangement of chapters is good, and the illustrations well chosen, including a few ancient ones, and a gorgeous coloured frontispiece of the Spanish eclipse of 1905 as it impressed a French lady artist. The final chapter on "The End of Things" indicates the direction of speculations by such different personalities as Camille Flammarion, J. E. Gore, and H. G. Wells. In addition to the plates there are some useful diagrams, and a satisfactory index is also provided. Altogether a book that can be confidently recommended.

BIOLOGY.

Man in the Light of Evolution, by J. M. Tyler (London: Appleton and Co., 1907; pp. xiv. and 231).—This little volume we have read with deep interest as it treats a difficult subject in a remarkably lucid and thoughtful manner, and from practically all points of view. Commencing with a chapter on Darwinism and following on with another on stages in human evolution, the author, who, by the way, is a Professor of Biology in an American college, strikes some very suggestive notes in the third, which is headed the logic of evolution. Here he specially emphasises the fact that there have been three stages or dynasties in the history of evolution; in the lowest animals the forces of development were mainly concentrated on producing adequate organs of digestion and reproduction; a stage higher, and we find muscle claiming all the energies of evolution; while in the culminating platform it is brain and mind that have come to the front. Later on Dr. Tyler invites the attention of his readers to the evolutionary problems of the family, society, morals, and religion, and in so doing expresses his sense of the importance of the study of the subject from the last two standpoints. Incidentally it may be mentioned that he is a believer in the inheritance of acquired characters. The volume closes with certain "genealogical trees" of animals in general and of vertebrates in particular, in the second of which he tentatively places the Cetacea below the Carnivora, this being scarcely in accord with modern ideas. We commend the book to all readers, and their name is legion, interested in evolution and its problems.

CHEMISTRY.

An Organic Chemistry. A. E. Dunstan, B.Sc. (London: Methuen and Co.; pp. viii. and 160; 2s. 6d.).—A better method of giving a student his first general grasp of the principles of organic chemistry than that adopted by the author of this little book could hardly have been devised. The preparation, properties, and reactions of ordinary alcohol are first described, then the various classes of derivatives that can be obtained from alcohol, and then step by step the student is shown how to prepare and to arrive at the constitutional formula of more complex compounds. Each exercise is made thoroughly practical, and forms a link with the one that follows. The book is well illustrated with diagrams and photographs of the necessary apparatus, and has a number of useful tables at the end giving the boiling and melting points of organic compounds of frequent occurrence.

An Intermediate Course of Laboratory Work in Chemistry. E. K. Hanson, M.A., F.I.C., and J. W. Dodgson, B.Sc. (London: Longmans, Green, and Co.; pp. viii. and 124; price 3s. 6d.).—This little handbook for the laboratory is thoroughly practical and should be found a useful guide not only by students preparing for the Intermediate Science Examination of London, but also by more advanced workers. It opens with a section on the preparation of various chemical compounds mainly of inorganic nature which are well selected so as to be typical of different classes of substances, and to illustrate the use of different kinds of apparatus. Then come exercises in quantitative, volumetric, and gravimetric analysis, followed by schemes for the qualitative analysis of a simple salt and directions for elementary spectroscopic work. The book is well arranged and clearly printed, the illustrations, reproduced from photographs of the apparatus, are excellent, and the index is exceptionally full.

The Theory of Valency, by J. Newton Friend, M.Sc. (London: Longmans, Green, and Co.; pp. xiv. and 180; price 5s.).—This is the most recent addition to the series of text-books of physical chemistry edited by Sir William Ramsay, and it fully justifies its inclusion. The history of

the theories of valency is practically an outline of chemical theory during the past 120 years. Not everyone has the gift of summarising and bringing out the salient points in complex theories, but this little work, concise without being dry, proves that the author possesses this gift. Beginning with the notions of chemical combination prior to the time of Lavoisier we are shown the gradual evolution of our modern theories of valency, by way of the atomic theory and periodic law, down to the latest electro-chemical theories. Not only are clear and readable outlines given of the theories put forward by the leading chemists of each generation, but in each case the agreement of the theory with observed facts is critically discussed. The ample references to original publications increase the value of the book, which undoubtedly fills a distinct gap in the literature of chemistry.

NATURAL HISTORY.

Consider the Butterflies, How They Grow, by L. P. Stubbs (London: Elliot Stock, 1909; pp. 63, illustrated; price 3s. 6d. net).—In its general style this little volume, although more plentifully interlarded with scriptural quotations, reminds us of the BRIDGEWATER TREATISES, its aim being apparently to emphasise the beneficence of the Creator, and to point out how Nature-study should lead to a higher appreciation of the Author of creation. Whether it will appeal to present-day readers remains to be seen. In his description of butterfly-structure, the author appears to be trustworthy, and the illustrations of the various species and their transformations if not, perhaps, first-rate are, at all events, attractive and well printed.

"Saint" Gilbert: The Story of Gilbert White and Selborne, by J. C. Wright (London: Elliot Stock; pp. 90, including index; eight illustrations; crown 8vo; 2s. 6d.)—We have heard the sanctification of Gilbert White in conversation, but this is, we think, the first appearance of "Saint" Gilbert in cold print. On the face of it, it looks silly and puerile, but there is little difficulty in understanding the writer's point of view. The cult of Selbornians is the open-air cult, and, in a sense, Gilbert White may be regarded as the patron saint of the cult. In a day of extreme specialisation there are hundreds of open-air lovers who fly to Gilbert White's "Selborne" when in difficulty. Most of those things to be met with in a country ramble are referred to by him. One cannot always carry a library about with one, but one can carry a "Selborne," and "Saint" Gilbert can easily be consulted. In White's life he may have done little to cause him to be regarded as a saint, but, unlike many other authors, he certainly did nothing which was not clean and saintly, and although the title is, of course, an exaggeration, it will please many readers. The illustrations are good, and convey a good impression of the village as it now is. Some of these days this now decaying village will come to be rebuilt, and such illustrations will be valuable. There is no illustration of "The Wakes." This is, perhaps, well. Each successive tenant "improves" the property, and now, perhaps, in view of recent events, fresh alterations will be considered necessary. Any who want a short, concise biography will find it in this little book.

PHYSICS.

Ellen, or Whisperings of an Old Pine, Vol. II., by Joseph Battell (Middleburg, U.S.A.: American Publishing Co.; London: A. F. Bird, 1908; 15s. net).—This book contains a large number of views of Vermont scenery, most of which include a figure in the foreground, which is presumably Ellen. These are not described in the accompanying letterpress, and consequently they lose the greater part of any value they might otherwise possess from the topographical point of view. The book itself seems to be an attempt to prove in some 740 pages that scientific men are considerably astray. We can only say that the author is apparently sincere; we cannot congratulate him on either the manner or the matter of his achievement. A complete failure on his part to understand a simple proof in connection with the velocity of sound is at the bottom of all his difficulties. We would help him out if we thought it any use; but we know of old that this sort goeth not out that way.

Text-Book of Sound, by Professor E. H. Barton (London: Macmillan and Co., 1908; 10s. net).—This is a much needed work, no work of exactly the same scope existing in the English language. The mathematics, which abounds necessarily in treatises on sound, is made as easy as possible. The treatment is simple but thorough. Much of the work, as the author claims, is intelligible to those not familiar with the calculus at all; for in the parts where it is used alternative methods are often given, which, though longer and in some respects more intricate, yet successfully replace it. We think, however, that the time spent in acquiring an elementary knowledge of the calculus is much more valuably expended than if the same time is spent in trying to avoid it. The book is practical as well as theoretical. One distinguishing feature is that various typical musical instruments are discussed more fully than usual. We consider this the most satisfactory text-book of sound which has yet been published.

MISCELLANEOUS.

Scientific Confirmation of Old Testament History, by G. Frederick Wright, D.D., LL.D. (London: Hodder and Stoughton, 1907; pp. 434; 6s.).—This is undoubtedly one of the best books of its class. It is full of scientific information gleaned in various parts of the globe, in illustration of the subject. The author says that the conclusions recorded in the volume were the cause of the establishment of the chair which he occupies, and the result of the generousness of its provisions. The chair in question is that which seeks to teach the harmony of science and revelation, and is held at Oberlin College, Ohio. Amongst the subjects dealt with are "Israel in Egypt," "The Exodus," "Traditions of the Deluge," etc. The author sees evidence of the Deluge in the Rubble Drift cliffs of Brighton, recently dealt with in our columns, but we are unable to regard these in the same light as the author. The same may be said of a good deal of the reputed evidence contained in the work. It will be, of course, understood that a book of this kind contains very much controversial material, which can scarcely be dealt with in the limits of a review. But for those who are interested in the subject as shown in the title, we know of no other similar modern book in which science takes its proper station. The illustrations, where taken from photographs, have unfortunately been spoiled through not being printed on appropriate paper.

Modern Steam Turbines, Vol. I., The Schulz Steam Turbine, by Max Dietrich (A. G. Owen, 28, Regent Street, London; 5s.).—This is the first volume of a series intended (as stated by the general editor, Mr. A. R. Liddell) to comprise descriptions of some of the systems of which encouraging trials have been made, or which have some other *primâ facie* claim to be taken seriously as engineering probabilities of the future. The volume is well produced; it contains numerous illustrations to scale of the turbine itself, and indicator diagrams of its performance. The descriptive letterpress is all that could be desired. It may be stated that in regard to matters of controversy between rival inventors, it is intended in this series simply to lay the *ex parte* statements before the reader without in any way showing editorial partiality.

The Internal Combustion Engine.—H. E. Wimperis (London: Constable; 6s. net).—No more satisfactory text-book exists on this subject than the one under notice. Mr. Wimperis brings to his task an adequate mental equipment and a full knowledge of the most recent work done in connection with an enquiry which is extending with very great rapidity, in line with the rapid development taking place on the practical side. The book is well illustrated; the data given include the most recent; even data from the report of the British Association Gaseous Explosions Committee have been included as the book went to press. Although the book is meant specially for students (a great number of problems gathered from examination papers and elsewhere being embodied in it), yet it will be of great use to the professional engineer. At the same time it is not entirely beyond the reach of the man with mechanical leanings who has not had the benefit of technical training, though some parts of it would be found to be too stiff by him. The specific heats at constant pressure given in the table on p. 98 are, unfortunately, called specific heats at constant volume; this will cause some confusion.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 118.)

An excellent stain for general work is—

Carbol Fuchsin.—Ziehl's formula is as follows :—

Fuchsin	1 gram.
Carbolic Acid Crystals	5 grams.
Alcohol	10 c.c.
Distilled Water	100 c.c.

Differentiate with alcohol as before. This stain is much used in medical work for staining tubercle bacillus, and differentiating is then done with acid, tubercle being distinguished as an "acid-fast" bacillus. The film on the cover-glass is put in the stain in a watch-glass and heated until the steam rises, perhaps several times. The film is then washed in water, and decolourised in, say, 20 per cent. solution of sulphuric acid for two or three minutes, which takes out the stain from all other elements except the bacilli. The film is again washed thoroughly in water, dipped for a couple of minutes into alcohol, and mounted in Canada balsam in xylol. If necessary, counterstaining may be done with methylene blue for, say, half a minute, but over-staining of the background must be carefully avoided, as it is important that the bacilli should be very marked.

Amongst the *plasmatic* stains I may take two as examples, of which the first is

Picric Acid.—This stain colours fibrin, fibrous tissue, skin, bone, etc., a bright yellow. It acts rapidly and is very penetrating and permanent. It is useful for staining objects whole, and is much used for small Arthropoda, Nematodes, etc. It is, of course, a very diffuse stain, and is often employed in combination with other stains as in Van Gieson's stain, to be next described. In using this stain it is only necessary to add a little picric acid to some alcohol, or to one of the alcohols used for dehydrating, but water must be avoided, nor should the alcohol, indeed, be of less strength than 70 per cent., as the fixation is thereby affected. Mr. Lee gives the useful reminder that alcoholic solutions to which picric acid is added should be *neutral* and not acid, as the presence of acid greatly increases its power of washing out carmine stains. After carmine stains, therefore, washing in acidulated alcohol is inadvisable, and it is only necessary to rinse, say, for two minutes in neutral alcohol of not less than 70 per cent. strength, and then to stain for a few minutes in picric acid, finally dehydrating in absolute alcohol for three to four minutes and clearing in cedar oil.

Van Gieson's stain is made up as follows :—

Acid Fuchsin, 10 per cent. aqueous solution ...	10 c.c.
Picric Acid, saturated aqueous solution ...	90 c.c.

This stain is often used with hæmatoxylin for fibrous or nerve tissue. Nuclei and epithelium are stained brown, white fibrous connective tissue red, elastic tissue and muscle yellow. Sections are slightly over-stained with hæmatoxylin, washed in water, and then put for, say, five minutes in Van Gieson's stain. The subsequent dehydration and clearing have a tendency to extract the colour given by the picric acid, so that both alcohol and clearing agent, such as xylol, may with advantage have a crystal or two of picric acid added.

(*To be concluded.*)

Royal Microscopical Society.

February 17.—Sir E. Ray Lankester, K.C.B., F.R.S., in the chair. The President, in thanking the Fellows of the Society for electing him President, observed that it was just fifty years since his father occupied that position, and the remembrance of that fact gave him additional pleasure in accepting the honour which they had conferred upon him. Dr. G. S. West contributed a paper on the "Red Snow" Plant (*Sphærella nivalis*), and the President remarked that he had seen this alga in alpine regions, particularly in a small lake near Grindelwald, which in the autumn was found to be full of it, but he had never seen it in the snow. Mr. A. A. C. E. Merlin contributed a paper on "A German-Silver Portable Microscope made by Powell in 1850," and Mr. E. M. Nelson a paper on "The Measurement of Very Minute Microscopic Objects." A letter was read from Dr. M. D. Ewell, in reply to criticisms made upon portions of his paper "On the Present Status of Micrometry," read at the November meeting of the Society. Mr. F. Enock gave a lecture on "The Transformation of Certain Insects," illustrated with excellent coloured lantern slides, the species dealt with being those which were common in suburban gardens, and were useful in destroying noxious insects. He showed how the common apnides, or green fly, were attacked by the larvæ of Lace-wing flies and House flies, the metamorphoses of which he traced. The destruction of aphides and of injurious larvæ by various species of ichneumon were also described and illustrated. The ravages of the minute black-currant mites (*Phytopti*) were mentioned, and views shown both of the creature and the result of its presence in the buds of black-currant bushes. The common "Devil's Coach-horse" (*Ocypus olens*), frequently regarded with aversion, and destroyed when seen, was shown to be an extremely useful insect in destroying injurious caterpillars. Illustrations were also given of "Fairy Flies" (*Mymaridæ*). Mr. Gurney contributed a paper on "The Freshwater Crustaceans of Algeria."

Quekett Microscopical Club.

March 5.—Mr. W. Wesché, F.R.M.S., communicated a paper on "The Structure of the Eye Surface, and the Sexual Differences of the Eyes, in Diptera." The fact that the eyes of the male insect are usually larger than those of the female is generally accepted as a secondary sexual character. The extreme case of development in this direction is met with in the Pipunculidæ, where the head of the male is nearly all compound eyes. In the multitude of species where the eyes are widely and equally separated in both sexes Williston has suggested the term "dichoptic" as the antithesis of "holoptic." The dichoptic condition is the primitive one. The second point noted was the division of the eye by an obvious structure into an upper and lower part as in some of the Bibionidæ. Third.—The facets in the upper portion of the eye may be larger than those in the lower part. The smaller ones being normal. It was suggested that the larger facets may have arisen as compensation for the failure of another sense such as the olfactory pits on the antennæ or the sense-organs that are sometimes found

on the male genitalia. Fourth.—In the curious Muscid family of the Diopsidæ the eyes are placed on long stalks which project from the head, maximum development noted in *D. apicalis*. Fifth.—The eyes are more or less pubescent. An account was given of certain experiments in this direction and the conclusion arrived at was that pubescence has but little to do with sight, and is probably protective. The last point dealt with was the presence or absence of chitinous structures round the lenses of the eyes.

Mr. T. B. Rosseter, F.R.M.S., read a note on "Some Work on the Genus *Hymenolepis*. He also described *Hymenolepis accicula-sinuata* sp. nov.

Notes and Queries.

B. F. C. (*Barnstaple*).—There are a good many books which deal with the preparation and mounting of objects for the microscope. Perhaps the best instructions for the beginner are the chapters devoted to the subject in Cross and Cole's "Modern Microscopy," but if you want more advanced methods for serious work you will need to consult larger works such as Bolles Lee's "Microtomists' Vade-Mecum," or Guyer's "Animal Micrology." You say you wish to investigate the anatomy of a sponge, and ask what acid you should use. If you wish to investigate cell-structure no acid must be used. Mr. Cole's method is generally useful. He recommends fixing fresh specimens with 1 per cent. osmic acid, washing in distilled water, placing in absolute alcohol for twelve hours, then soaking in absolute alcohol and ether for a few hours more, infiltrating and embedding in celloidin, and cutting the sections in a microtome. The sections are then placed in absolute alcohol for about three minutes, cleared in oil of origanum, and mounted in Canada balsam. To investigate the skeleton and spicules, horny and calcareous sponges are boiled in liquor potassæ (say, 5 per cent.), whilst siliceous sponges should be boiled in strong nitric acid. They are then washed well in water, and mounted in Canada balsam or glycerine jelly. Sections are hardened in methylated spirit, transferred to equal parts of ether and absolute alcohol for several hours, then infiltrated and embedded in celloidin, and cut in a microtome. After cutting dehydrate in methylated spirit, clear in oil of bergamot and mount in Canada balsam. For more detailed and advanced procedure for special study you must refer to Mr. Lee's book above mentioned. The only journal dealing with general microscopical science, and abstracting all recent microscopical work at home and abroad in botany, zoology, embryology, etc., is the Journal of the Royal Microscopical Society, a publication of the utmost value. For human anatomy on the non-microscopical side you must refer to such periodicals as the Journal of Anatomy and Physiology, for zoology to the Abstracts of the Zoological Society, to papers in the Linnean Society's Journals, etc., but I must warn you that these are for the most part for trained workers only. The only way to find out "what work is being done, and what remains to be done," is to work at a subject oneself—it is impossible to summarise popularly any single subject, to say nothing of all. Certainly, there is any amount of original work to be done, and much of it can be done by non-professional workers, but it is no use looking around for such work, the attention must be directed to some definite subject, however small, and that one subject must be mastered.

J. P. (*Bath*).—I do not think you will get satisfactory results with a binocular microscope with any higher power than a half-inch, and a two-thirds would be preferable. There is no advantage in this connection in high aperture—rather the contrary. For a higher power to be used with the single tube, I think, you will get most satisfaction out of a one-sixth inch, and I would suggest Watson's new $\frac{1}{6}$-inch, which has a working distance of not less than a millimetre. When ordering it would be advisable to have it corrected for an eight-inch tube. I would not recommend you to get a × 12 eyepiece, the × 8 eyepiece which you already have is quite as high as achromatics will stand satisfactorily, and you will find that you lose more than you gain by any higher eye-piecing.

M. A. A.—It is most difficult to advise anyone as to what work to take up with the microscope, and your isolation on board ship makes it still more difficult! On the other hand, you get opportunities of visiting many foreign places. Why not try foraminifera, or marine algæ, or zoophytes? You could name the species on your return home, and would have no difficulty in getting help in the naming of the rarer species if you showed a real interest and not merely a curiosity in the subject. I shall be glad to suggest books to make a start with when you have made a decision. With regard to your questions, when you have obtained critical illumination it is quite justifiable to turn the lamp round without altering its adjustments, so as to use the flat of the flame, and you will not find the image suffer except on the most critical work. But even the flat of the flame will not give you a completely illuminated field with low-power objectives, and that is why the bull's-eye is generally used for this purpose. If you will refer again to my "Elementary Microscopy," page 135, you will find that in explaining how to fill the field with light by its means I expressly mention that its spherical and chromatic aberrations render it unsuitable for really critical work, and that on page 129 I explain how the flame can be turned broadside on after focussing and centring. I do not quite follow your question as to the use of an ordinary camera in photo-micrography. If you suggest using the ordinary photo lens to collect the image given by the microscope with ocular *in situ*, this will be most unsatisfactory, as the rays transmitted by the latter are not parallel to the optic axis or they would not form a projection image, as is easily demonstrable. You will get very bad definition and the photograph you sent me, which is apparently Arachnoidiscus, is very unsatisfactory. You have only to compare it with the original to see its imperfections. At the same time, if you remove the lens from your camera and use it merely as a photographic camera it will do quite presentable work. The light-tight connection between camera and microscope can be made of a sleeve of black velvet and a couple of rubber bands, but it will be very difficult to maintain the focussing for any but low powers when the slide is withdrawn. A piece of cardboard put before the objective can serve as a shutter.

Microscopical slides.—Messrs. Flatters and Garnett, Ltd., of Manchester, have sent me for inspection some new zoological and botanical slides which deserve notice. Amongst these was a slide of amœba, showing that these difficult organisms can be permanently preserved and mounted in a fairly satisfactory condition, a beautiful slide of Cordylophora (a freshwater medusa) which was exquisitely transparent and showed the processes well, equally beautiful and transparent slides of Squilla and of Leptodora, a very fine slide of Salpa showing its curious egg-chain, and last, but not least, one of Mr. Enock's well-known mounts, a very dainty slide of Anagrus—the fairy fly. Amongst the botanical slides were a vertical section of Laminaria showing the sporangia very clearly, and equally good slides of Œcidium, and of Cystopus. Messrs. Flatters and Garnett state that they are always willing to send selections of slides on approval.

Botanical Photo-micrographs.—Mr. P. H. Johnson, of 19, Bingham Road, Sherwood, Nottingham, is issuing a series of photo-micrographs of various botanical sections, taken direct from the slides, with a view to facilitating botanical study, more especially for those who do not possess either microscopes or slides of their own. The prints are on bromide paper, about 2 ins. square, are mounted on cards, and the important structures noted. They represent the usual type slides used by students for examination, and are arranged in sets for first or second year students. The cost is 4s. per doz. Lantern slides can also be obtained. The specimen photo-micrographs submitted to me were good reproductions and showed detailed structure well.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for April.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.40 and sets at 6.30; on the 30th he rises at 4.38 and sets at 7.18. The equation of time is negligible on the 15th and 16th, hence these are convenient days for the adjustment of sundials. Sun-spots and faculæ may still be seen on the disc, and the spectroscope still shows a number of prominences on the limb. The position of the Sun's axis, equator, and heliographic longitude of the centre of disc is shown in the following table :—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
April 1 ..	26° 19′W	6° 29′	104° 4′
,, 6 ..	26° 26′W	6° 10′	38° 5′
,, 11 ..	26° 23′W	5° 50′	332° 5′
,, 16 ..	26° 8′W	5° 26′	266° 4′
,, 21 ..	25° 42′W	5° 1′	200° 1′
,, 26 ..	25° 5′W	4° 32′	133° 58′

THE MOON :—

Date.	Phases.	H. M.
April 5..	○ Full Moon	8 28 p.m.
,, 13..	☾ Last Quarter	2 30 p.m.
,, 20..	● New Moon	4 51 a.m.
,, 27..	☽ First Quarter	8 36 a.m.

OCCULTATIONS.—The following are the occultations of the brighter stars visible at Greenwich :—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.	
			p. m.		p. m.		d. h.
April 3	ν Virginis ..	4·2	9 55	94°	11 5	333°	12 2
			a. m.		a. m.		
,, 8	μ Librae ..	5·4	2 14	133°	3 30	282°	17 7
,, 11	*b* Ophiuchi ..	4·3	3 52	41°	4 32	341°	20 8

THE PLANETS.—Mercury (April 1, R.A. 23h 35m; Dec. S. 5° 17′. April 30, R.A. 3h 6m; Dec. N. 18° 33′) is a morning star in Pices during the early part of the month; but for all practical purposes is unobservable as he only rises 20 minutes in advance of the Sun. The planet is in superior conjunction with the Sun on the 21st.

Venus (April 1, R.A. 0h 17m; Dec. N. 0° 19′. April 30, R.A. 2h 31m; Dec. N. 14° 2′) is unobservable throughout the month as the planet is in superior conjunction with the Sun on the 28th.

Mars (April 1, R.A. 19h 46m; Dec. S. 22° 5′. April 30, R.A. 21h 6m; Dec. S. 18° 14′) is a morning star in Capricorn, rising at 2.40 a.m. on the 16th. The brightness and apparent diameter of the planet are increasing as the opposition, which takes place in September, approaches. The low altitude of the planet is detrimental to easy observation in small telescopes.

Jupiter (April 1, R.A. 10h 33m; Dec. N. 10° 38′. April 30, R.A. 10h 28m; Dec. N. 11° 4′) is a brilliant object in the evening sky and well placed for observation, being due South at 9 p.m. on the 14th. For small telescopes this is the easiest and most interesting planet to observe, on account of his brightness, attendant moons, the markings on the disc, and polar flattening. If sufficient magnifying power be used the Great Red Spot on the belts may also be observed, and the period of rotation deduced. This is about 9h 55m. The equatorial diameter of the planet is 42″, whilst the polar diameter is 2″·7 smaller.

The following table gives the satellite phenomena observable in this country between 7.30 p.m. and midnight :—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Apl.				Apl.				Apl.			
1	I.	Sh. E.	8 9	11	II.	Oc. D.	8 27	22	I.	Tr. I.	10 31
2	II.	Tr. I.	11 2	14	I.	Oc. D.	11 22		I.	Sh. I.	11 35
3	III.	Sh. I.	8 45	15	I.	Tr. I.	8 42	23	I.	Ec. R.	10 59
	III.	Tr. E.	9 5		I.	Sh. I.	9 40	24	I.	Sh. E.	8 22
4	II.	Ec. R.	10 29		IV.	Tr. I.	10 30		IV.	Ec. R.	10 4
7	IV.	Oc. R.	8 16		I.	Tr. E.	11 1	27	II.	Sh. I.	9 37
	I.	Oc. D.	9 34		I.	Sh. E.	11 59		II.	Tr. E.	10 16
8	I.	Sh. I.	7 45	16	I.	Ec. R.	9 4	28	III.	Oc. R.	9 27
	I.	Tr. E.	9 13	18	II.	Oc. D.	10 50		III.	Ec. D.	10 41
	I.	Sh. E.	10 4	20	II.	Sh. E.	9 52	30	I.	Oc. D.	9 29
10	III.	Tr. I.	9 8	21	III.	Ec. R.	9 54				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (April 1, R.A. 0h 51m; Dec. N. 3° 1′. April 30, R.A. 1h 4m; Dec. N. 4° 23′) is unobservable throughout the month, being in conjunction with the Sun on the 3rd.

Uranus (April 15, R.A. 19h 31m; Dec. S. 22° 14′) is visible in the mornings, rising about 2 a.m. near the middle of the month. The planet is at quadrature on the 11th.

Neptune (April 15, R.A. 7h 2m; Dec. N. 21° 57′) is on the meridian at 6.30 p.m. on the 1st, and sets at 2.30 a.m. The planet is situated in Gemini, about 1° North-East of the star ξ Geminorum.

METEOR SHOWERS :—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
Apr. 17-May 1	16 0	+47°	τ Herculids	Small; short.
,, 20-21 ..	17 24	+36°	π Herculids	Swift; bl. white.
,, 20-22 ..	18 4	+33°	**Lyrid Shower**	Swift.
,, 30 ..	19 24	+59°	*o* Draconids	Rather slow.

Algol may be observed at minimum on the 19th at 9.43 p.m.

TELESCOPIC OBJECTS :—

DOUBLE STARS.—γ Virginis, XII.h 37m, S. 0° 54′, mags. 3, 3; separation, 5″·6. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of magnifying power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.h 36m, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 40.

ε Boötis, XIV.h 41m, N. 27° 30′, mags. 3, 6½; separation 2″·6. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue green.

ξ Boötis, XIV.h 47m, N. 19° 31′, mags. 5, 7; separation 2″·4. Binary; one component being orange, the other purple.

CLUSTERS.—M 3 (*Canes Venatici*) XIII.h 38m, N. 28° 48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.